Hedging Risk
in
Commercial Real Estate

by

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ABSTRACT

This paper examines the feasibility of hedging volatility in commercial real estate property returns using mixed portfolios of public equity securities. The various components of the Russell–NCREIF Index were used as proxies for the returns series. The appraisal smoothing and lag effects in the indices were removed to uncover true returns using autoregressive methods (see Fisher, Geltner and Webb (1994)). Hedge portfolios were determined for the total national index as well as for the Southeast and West /Retail sub–indices. Hedge ratios were determined by running stepwise regressions of the property returns on a basket of securities. The resulting hedges were then tested in out–of–sample periods. The results indicate that it is not possible to hedge away risk by following this strategy. Although the R^2s obtained from the regressions were relatively high, the relationship between the two markets appears too unstable to hold up outside the sample period. The hedged portfolios actually displayed more volatility than the unhedged portfolios.

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Obviously, the responsibility for any errors and omissions contained herein remains with me.

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Hedging Risk in Commercial Real Estate

Chapter 1: Introduction

Real estate constitutes the largest portion of national wealth in the United States. It therefore represents a significant asset class which arguably should be included the "market portfolio" for investors who desire to hold truly diversified portfolios. Estimates of the value of institutional–grade commercial and multifamily real estate in this country range from $815 billion to $4.7 trillion.[1] Until fairly recently most investors viewed real estate as a safe haven, expecting that prices would continue to appreciate in value forever in a relatively stable fashion. That particular myth, however, was shattered by the real estate crash of the late 1980s

The size of the asset class, as well as the recent negative market experience, means that a considerable amount of attention has been focused on the question of the level of future real estate prices. This interest in future prices is shared by both academics and practitioners, as well as the general public, who have a very real concern since their homes probably represent their single largest investment and most of their wealth. Predicting future real estate prices, however, has been likened by some to reading the entrails of animals. The market is subject to the economic laws of supply and demand, which in turn are affected by numerous factors which change continually and often in an unpredictable fashion. It is therefore extremely difficult to predict what price levels and returns from real estate will be in the future with any degree of certainty.

A more practical line of inquiry is to ask to what extent prices will fluctuate in the future. Stable prices reflect a less risky environment than a one in which prices display large fluctuations. Increasing volatility (increasing risk) translates into greater uncertainty regarding rates and prices. Since investors expect to be compensated for holding risk, they need to know the degree of risk that they will be exposed to in order to decide whether or not the returns generated are adequate compensation. If the perceived risks associated with real estate worsen, the yields may not be enough to entice investors to purchase real estate as opposed to other asset classes.

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[1] See Miles (1990).

Risk is measured by price volatility, which in turn is defined as the degree to which prices deviate about their average value, termed the mean. The statistical terms used to quantify volatility are variance and standard deviation. Variance is the square of the difference between the mean of a series of observed values and a particular observed value. Financial prices are typically dealt with as time series, so the price variance on a particular day (assuming prices are reported daily) would be the square of the difference between the average value over the period under investigation and the price on the day in question. The variance over the entire period observed is the sum of the individual daily variances divided by the number of days in the period, less one. Standard deviation is simply the square root of the variance, which makes it somewhat easier to use intuitively than variance since it is expressed in units of percent rather than percent squared.

There is little doubt that the financial world has undergone a tremendous transformation over the past several decades. This transformation has been accompanied by an increase in volatility as well as an increased awareness in the financial community of and attention focused on managing one's exposure to the increased risk. The explosion of financial derivatives over the last ten years or so is the direct result of this riskier environment. Both "plain vanilla" and exotic derivative securities are widely available in today's marketplace, with new derivatives constantly appearing. The lexicon of the modern trader of these instruments would be unintelligible to practitioners only a few short years ago. These derivatives have been developed to manage volatility, thus allowing financial institutions to better manage their portfolios. Since price uncertainty cannot be eliminated, a more effective course of action is to actively manage the associated risks using these new financial tools.

In general, financial time series are characterized by changing volatility. Because of this, future forecasts of volatility are desirable in order to ensure that the investor is fairly compensated. For investors in the stock market, this can be accomplished relatively easily. Stock option prices, which are determined by the market, are used to arrive at an implied volatility for the stock. Since the stock options are for a future exercise date, the implied volatility indicates the level of uncertainty in the forecasts of price stability in the future. Option pricing techniques, such as the Black–Scholes formula or the Binomial Option Pricing Model are typically used. All the information required by the formulas, such as the current stock price, the exercise price and the exercise date, is readily available. The only unknown remaining is the volatility. Plugging in the stock option price and "inverting" the formula results in a value for the implied volatility.

Forecasts of implied volatility for real estate, however, are not as straight forward. Unlike stocks, bonds and commodities, real estate assets are not traded on a day–to–day basis. As a result, market prices are not readily available. Further, no market exists for trading options on real estate, so calculations similar to those performed for stock options cannot be performed. Holland, Ott and Riddiough (1995) derived forward looking estimates of the volatility in the commercial real estate market. The implied volatility of property prices was computed, in part, using the spread between commercial mortgage rates and Treasury bonds of comparable duration. Assuming the commercial mortgage rates as given, the implied volatility for the property value was calculated by determining the value required to produce the observed loan rates. They found volatilities which fluctuated widely, ranging from 15 to 25 percent over the period from the 1st quarter of 1979 through the 4th quarter of 1993. The results are shown in Figure 1.1.[2]

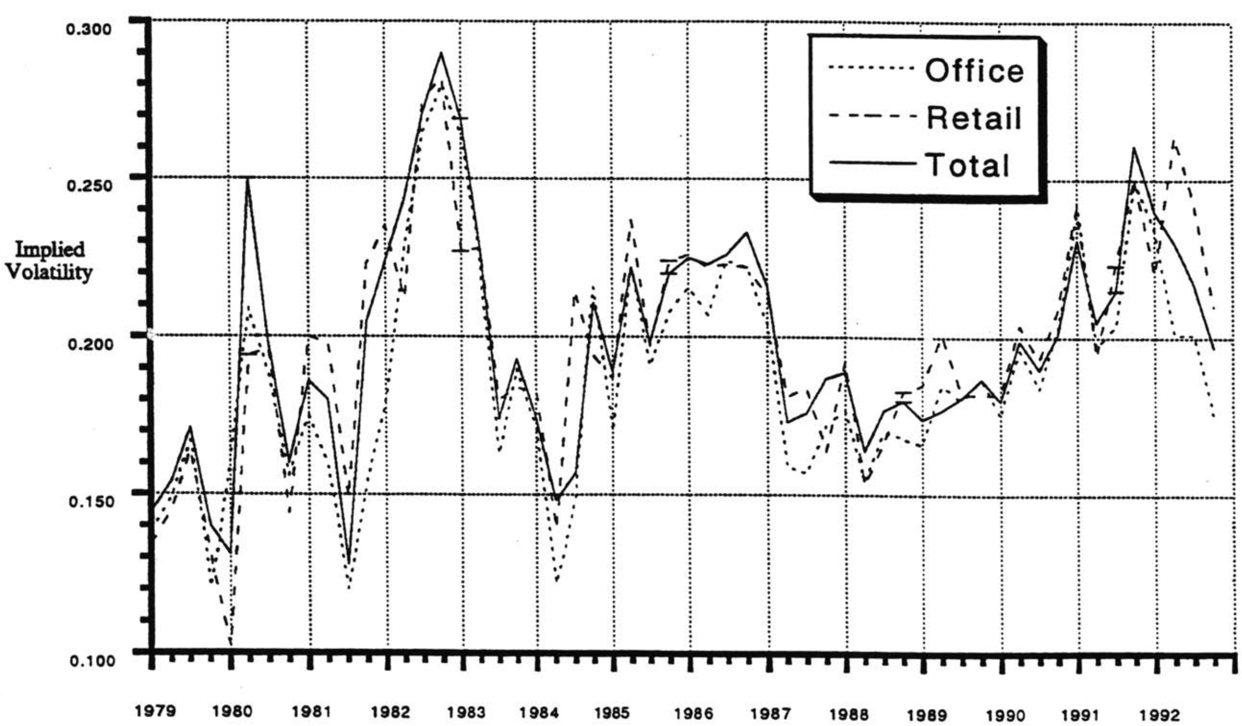

Figure 1.1

[2] See Holland, Ott and Riddiough (1995).

1.1 Risk Management in the Real Estate Industry

To date, the subject of managing volatility in the real estate industry has not received much attention. The reason for this is probably related to the long–held belief that real estate values never decline. Given the certainty of a rising market, there is no reason to hedge the risk that prices might move down. However, as we have recently witnessed, that particular adage has been proven to be false. Real estate, like all financial classes, is subject to the vagaries of the market, where prices can fall just as easily as they can rise.

Only a few real estate related derivative instruments have been available for trading on the world's exchanges. The London Futures and Options Exchange (London FOX) began trading the following property futures contracts in May 1991:

1. A residential property contract, cash settled on the Nationwide Anglia House Price Index, which is a regression–based hedonic price index.

2. A mortgage interest rate contract, based on the MIR (Mortgage Interest Rate) Index. The MIR was constructed by the FOX using daily weighted interest rates provided by a panel of 25 lenders representing approximately 80 percent of the mortgage lending done in the United Kingdom.

3. A commercial property capital values contract, cash settled on the IPD (Investment Property Databank) monthly index of real estate prices. The IPD was based on the assessed values of commercial properties held by 31 funds.

4. A commercial property rents contract, cash settled on the IPD commercial rent index.

Sufficient trading volume never materialized and the FOX suspended the contracts in October of the same year after it was reported that trading volume had been artificially supported by the exchange.[3] Several reasons might have been responsible for the poor trading volume experienced by the FOX. Lack of familiarity with the futures contracts on the part of investors could have been one of the problems. It has been noted that when

[3] See Patel (1994).

Treasury bond futures were first introduced in the United States, the initial trading volume was disappointing. However, these futures contracts are now traded extensively and have become extremely successful.[4]

The success of a futures contract depends on a number of factors. Obviously the contract must prove useful to potential users. In order for this to be true, the specification of the contract must be compatible with the cash market for the underlying asset. If not, the potential for non–parallel price and volatility movements arises which would not only reduce the hedging effectiveness of the contract, but could also potentially make the hedged position riskier than the unhedged position.

Liquidity and volatility must be present in both the cash and futures market. There is insufficient volume in illiquid markets to attract the interest of traders. Futures markets with a very illiquid cash market also pose a problem for hedgers, since it might not be possible to hedge long–term risk.

> " Suppose that information becomes available that real estate prices will decline over the next three years. Because the cash market is sluggish and inefficient, this information is not fully incorporated in real estate prices and hence not in current short–term futures prices. As investors roll over the futures contract, in subsequent years, they will find that the futures prices will reflect the information, so that the risk is no longer insurable.
>
> In short, holders of an existing short–term contract are not compensated for the fact that they must now confront very unfavorable terms when they roll over the futures contract."[5]

Lack of volatility means little potential for large price movements and profits, minimizing speculator interest in the contract.

Lastly, full price information for the underlying asset must be readily available. This condition is clearly not satisfied by real estate, where transactions occur infrequently and price information is often established by appraisals rather than through the mechanism of

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[4] See Case, Shiller and Weiss (1993), p. 91.
[5] *Ibid.*, p. 89.

the marketplace. In such an environment, the conventional method of establishing the price of the futures contract through arbitrage pricing relationships is simply not possible.[6]

On February 21,1995, the Chicago Board Options Exchange began trading options on their CBOE REIT Index. The index is a price–weighted index of equity securities of 25 Real Estate Investment Trusts (REITs) currently trading on the NYSE or AMEX. The REITs presently comprising the index are shown in Table 1.1. The options are European–style options, which means that they can be exercised only on the expiration date. Underlying value is $100 times the index value. The options are cash settled based on the difference between the settled value at expiration and the exercise price of the option. Trading to date has not been particularly heavy, possibly for reasons similar to those experienced by the FOX with their real estate related futures contracts.

A major difference between the real estate market and the securities market is that it is much easier to rebalance portfolios in the latter case. For a multitude of reasons, it is generally not possible to go out and sell a major piece of commercial real estate for the asking price at a moment's notice. The real estate market is highly illiquid. In a soft market, large institutions may wish to hold onto their real estate assets rather than sell them at disadvantageous prices, trusting that the market will turn. The use of another financial derivative, which allows institutions to continue to hold their assets, was seen in 1993, when Morgan Stanley engineered a swap deal with AEW, a Boston–based fund manager. The fund was able to swap its exposure from real estate to foreign equities without liquidating its holdings. This is believed to be the first real estate–related swap carried out in this country. It is, however, unlikely to be the last. Both the size and volatility of the real estate market make it an attractive area for the institutions active as originators, developers and market makers of derivative instruments.

Unlike other asset classes, such as stocks, bonds and commodities, little academic research has been performed regarding hedging risk in real estate. A recent Bankers Trust Research paper examined constructing a real estate index comprised of exchange–traded REITs, REOCs and small–cap stocks.[7] The resulting index displayed good correlation with the Russell–NCREIF index (RNI), suggesting that it could potentially be used as a tool for hedging. The RNI, which is discussed in greater detail in Chapter 2, is a widely–used indicator of the performance of commercial real estate in the United States.

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[6] See Patel , p. 359.
[7] See Kerson (1994).

REIT	Share Price	Weight
American Health Properties Inc.	21.250	3.93%
Avalon Properties Inc.	19.125	3.54%
CBL and Associates Properties Inc.	20.000	3.70%
Duke Realty Investments Inc.	26.250	4.85%
DeBartolo Realty Corp.	14.000	2.59%
Equity Residential Properties Trust	26.625	4.85%
Federal Realty Investment Trust	20.875	3.86%
General Growth Properties Inc.	20.750	3.84%
Glimcher Realty Trust	19.875	3.67%
Health Care Property Investors Inc.	28.750	5.31%
Kimco Realty Corp.	36.125	6.68%
McArthur Glen Realty Corp.	15.375	2.84%
Manufactured Home Communities Inc.	16.625	3.07%
Merry Land and Investment Co.	20.375	3.77%
Nationwide Health Properties Inc.	36.250	6.70%
New Plan Realty Trust	20.625	3.81%
Post Properties Inc.	29.875	5.52%
Property Trust of America	16.875	3.12%
Storage Equities Inc.	14.000	2.59%
Simon Property Group Inc.	22.875	4.23%
Spieker Properties Inc.	20.500	3.79%
Taubman Centers Inc.	9.125	1.69%
United Dominion Realty Trust Inc.	13.375	2.47%
Washington Real Estate Inv. Trust	16.250	3.00%
Weingarten Realty Investors	35.250	6.52%

Table 1.1

Large commercial real estate is expensive. Acquisition of a downtown office building will cost the purchaser many millions of dollars. The transaction costs related to the acquisition are also high. In an environment of relatively low volatility, an investor can forecast with relative certainty the expected returns from the acquisition. When volatility/risk increases, this is not as easily accomplished. Is there any way for the investor to protect himself from this risk? The aim of this thesis, therefore, is to address in part the lack of existing research on this subject by asking the following question:

> *Can commercial real estate be hedged by creating synthetic positions comprised of various traded and/or customized securities?*

1.2 Potential Advantages of a Suitable Hedging Strategy for the Real Estate Community and Potential Investors

If we assume as an approximation that the loss in property values due to the recent real estate crash was 40 percent, the total loss for investors in commercial and multi–family real estate in the United States, using the figures cited earlier, would range from $325 billion to nearly $2 trillion. In addition to the price tag associated with the Savings and Loan bail out, these colossal losses have caused a major reorganization of the real estate industry in this country. A further result is that pension funds who invested sizable sums in real estate in the 1980s are now seriously questioning whether real estate is an asset class in which they should be investing.

The large losses suffered by holders of commercial real estate during the last crash could have been mitigated to some extent if a method of hedging price volatility had existed. One might ask why not just sell the properties rather than hedge them. This, however, ignores the illiquid nature of real estate as well as the presence of the considerable transaction costs involved. These two factors make executing an exit strategy much more difficult. Selling could be a possibility, but selling at a reasonable price in a declining market would probably not be possible.

A suitable hedging mechanism for real estate would be a security whose price, in general, either moves in lockstep with or in opposite directions to movements in property prices. In the case where price movements parallel each other, the hedge is set in place by taking an opposing position in the security. For example, an investor who owns real estate would want to short the security, essentially selling it and borrowing equivalent shares for purchase at a later date. If prices fall, a gain is made since the shares are bought back at a price below that at which they were purchased. This gain offsets the loss experienced by the property value. If price movements between real estate and the hedging security are expected to be in opposite directions, the investor takes a long position in the security, buying it. When property prices decline, the loss is offset by the gain made on the security.

The substantial costs associated with acquiring and holding commercial real estate preclude a potentially large number of investors from participating in the market. The existence of a suitable hedging mechanism could provide an opportunity for these investors to replicate a position in real estate without incurring the very large transaction and holding costs. This would enable an investor to reap the upside benefits in a rising real estate market without physically owning the assets.

Another potential advantage would be increased liquidity for the hedger holding a synthetic position rather than the physical assets. For instance, the acquisition of a commercial office building can take a considerable length of time. It does not happen overnight. Due diligence, arranging of financing, negotiations between the buyer and seller, etc. require, as a minimum, several months to complete. An investor in a synthetic portfolio could be in and out of the market many times in the period that it would take to complete a typical acquisition or disposition.

In addition to the hedging opportunities that they would offer, if futures and options were available for real estate several other benefits would accrue. Liquidity would improve, resulting in lower transaction costs for participants in the market. Price discovery would also be enhanced, since a consensus regarding prices would be established by the markets on a continual basis rather than by the infrequent sales of the physical buildings themselves.

The existence of suitable hedging instruments may also enable pension funds to better utilize their asset allocation models. One of the most frequently heard arguments regarding the use of Modern Portfolio Theory in real estate is that the model may tell you to do one thing which is not possible in the physical sense due to the "lumpy" nature of properties. For example, the asset allocation model may indicate that a fund should be diversifying by buying a specific property type in a certain geographic region. Upon questioning brokers in that region, however, it turns out that there are no buildings available of the type that the fund is looking for. If a replicating portfolio could be constructed which mimicked the risk and return characteristics of the desired property type, it could be used instead. As discussed above, it is probable that this synthetic position would also have the advantage of being much more liquid than its physical counterpart. These advantages might make it possible for pension funds to allocate larger percentages of their total funds to real estate than they do at present.

1.3 Research Methodology

In order to determine returns from commercial real estate, the Russell–NCREIF Property Index (RNI) was used as a proxy. The returns series for the index was provided by the Frank Russell Company. Coverage was from the 1st quarter of 1978 through to the 4th quarter of 1994. Since the RNI is an appraisal based index, it does not necessarily represent true property returns due to problems associated with the construction of the index. In order to arrive at a true returns series, the RNI and its sub–indices had to first be "unsmoothed" and "de–lagged." A detailed discussion on the RNI and the unsmoothing methodology used is contained in Chapter 2.

In addition to the national index (total RNI), the series is comprised of 37 sub–indices. These are classified by region, division (sub–region), property type and region combined with property type. For the hedging feasibility analysis, the total RNI and the sub–indices for the Southeast and West/Retail were examined.

Chapter 3 contains a brief discussion on hedging. The basic methods for estimating optimal hedge ratios, the mean–variance approach and the OLS regression approach are covered.[8] The discussion does not into great depth, but is only intended to provide an introduction for what follows in the later chapters.

The relationship between the commercial property markets and the public equity markets is explored in Chapter 4. Four indices were used as proxies for the equity markets. The four are the S&P 500, the Russell 2000, the Value Line Index and the Wilshire Small Cap Index. Each one of these indices is traded on the exchanges. Cross–correlation coefficients between the unsmoothed RNI (total plus 21 sub–indices) and the equity indices were calculated. For the most part, little correlation was seen. In the few instances where

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[8] OLS refers to ordinary least squares estimation. This involves generating parameter values through regression analysis that minimize the sum of the squared residuals. The residual is the difference between the observed value and the value estimated from the regression. The process is best thought of as trying to find the best fit for a line through a given set of data points.

somewhat stronger correlations were in evidence, the relationship was further examined by running OLS regressions with the specific RNI as the dependent variable and the equity index as the independent variable. It was found that little variation in the RNI could be explained by the equity markets as a whole. The time spans examined were two and four year periods. Over the shorter period, there are several years when higher R^2s are seen, suggesting that there may be periods of shorter duration over which the relationship is much stronger. The problem one runs into, however, is that returns are only reported quarterly. There are not enough observations in the shorter periods to arrive at statistically meaningful results.

Given the regional nature of real estate ("location, location, location"), the feasibility of hedging commercial property at the national level was explored in Chapter 5. A database containing the quarterly returns for a variety of securities was assembled. Quarterly returns were computed using the appreciation in the share price over the quarter plus any dividends declared. Where possible, data was collected for time periods contemporaneous with the RNI series. The securities considered for the total RNI hedge included companies having a hypothetical connection with real estate, such as large insurance companies and banks, or an obvious connection, such as REITs. Possible hedging securities were identified using stepwise regressions. The hedged portfolios found from these regressions were then tested in out–of–sample periods to establish the effectiveness of the hedge. The results showed that the hedges derived from this strategy did not succeed in neutralizing volatility.

Since real estate is often held in a specific geographic area and by property type, it was decided to examine whether it was possible to hedge at the RNI sub–index level. This forms the contents of Chapter 6. The two indices chosen were the Southeast index and the West/Retail index. In the case of the Southeast hedge, the largest publicly traded companies in the region were used in the basket of possible hedging candidates examined. This method is somewhat simplistic since it does not take into account the issue of where the companies' profits are generated or look at the flow of goods into and out of the region. The method used, however, was felt to be a reasonable first approximation and adequate for this analysis. The companies used in the West/Retail analysis included many of the largest publicly traded firms in the West, but the selection used was limited primarily to retailers. The results obtained were similar to those found at the national level. The hedged portfolios, rather than reduce volatility, actually displayed greater volatility than the unhedged portfolios.

Chapter 2: Real Estate Indices

In this study we are concerned primarily with the benchmark characteristics provided by the Russell–NCREIF Property Index (RNI), the most widely cited index for commercial property returns in the United States. The index will be used to arrive at a time series which will serve as a proxy for real estate returns in the ensuing hedging analyses.

A major difference between real estate and other asset classes, such as stocks and bonds, is the transaction frequency. The latter are regularly traded and priced in the financial markets. Real estate transactions, however, occur infrequently. On average, only 38 properties per year have been sold from the Russell–NCREIF Index over the period from 1978 to 1992.[9] Assuming that this is indicative of the turnover for commercial properties, most properties are bought and sold on average roughly once every 20 years. In other words, only about 5 percent of the total stock of commercial real estate in this country is sold in a given year. Instantaneous market prices are therefore not available for the majority of the stock of commercial real estate in the United States.

Lacking a real time market driven pricing mechanism, the industry has had to rely on appraisals for estimates of current market values and the associated returns from commercial real estate. Appraisal–based returns series, however, are subject to certain effects related to the construction of the index. It is necessary that practitioners in the industry who use these series in analyses understand these effects and the problems associated with them. The largest problem is that the volatility of the series is underestimated. The reduced volatility is primarily the result of the appraisal process at the individual property level. A more detailed discussion on this topic is contained in Section 2.1. The understated volatility has serious implications for any analysis based on mean–variance theory, such as asset allocation models or OLS hedging strategies.[10]

Although appraisal–based series contain a lot of valuable information, for the purposes of hedging analyses it is obviously preferable if some way can be found to extract the true returns, and hence true volatility, from the series. It should be possible to model the appraisal behavior if it could be shown to be consistent. Once this has been accomplished, by working backwards and inverting the process one should be able to arrive at the true

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[9] See Miles, Guilkey, Webb and Hunter (1992).
[10] Variance terms are found in the equations used in such analysis.

returns. This methodology, which we shall refer to as unsmoothing, is discussed in detail in the following sections.

The recent trend toward securitization of real estate has been lauded by many in the industry as a first step away from the appraisal–based system toward a system in which the market establishes prices. It is generally felt that market–based valuations will greatly reduce the pricing inefficiencies which presently exist. The total amount of real estate which is currently securitized, however, is a tiny fraction of the total stock, so it would appear that the appraisal system will be with us for the foreseeable future.[11]

2.1 Index Smoothing at the Disaggregate Level

The nature of appraisers and the appraisal process results in smoothing at the disaggregate (individual property) level. Appraisers, like accountants, tend toward cautious and conservative reporting. This is both natural and expected since the lack of instantaneous market prices dictates that current market values can never be precisely known. It is likely that appraisers will always have a certain amount of doubt regarding the value arrived at under any appraisal scenario.

Appraisers are usually aware of the most recent appraisal and frequently utilize the information contained in it when performing a new update. Given the presence of doubt discussed above, it makes perfect sense for them to utilize this information. An additional problem for the appraiser is that it is probably more difficult for him or her to report and explain large changes in value from the previous appraisal than it is to report small changes. This is particularly true when the update is being performed by the same appraiser who carried out the previous appraisal. Given all this, a rational behavioral model arises in which only partial adjustments to property values result when they are estimated by the appraisal process. A "tyranny of past appraisals" prevails under this model. The end result is partial adjustments to market values and subsequent appraisal smoothing and reduced volatility at the index level.

[11] The total value of Real Estate Investment Trusts (REITs) in the United States at the end of 1994 was $44.3 billion. This represents less than 1 percent of the value of all real estate in the country.

It is possible to represent the "rational appraisal" model in the following manner. The relation between the appraised property value and the market value is given by:

$$V_t^* = \omega V_t + (1-\omega)V_{t-1}^* \tag{2a}$$

Where: V_t^* = rational appraised value for year *"t"*

V_t = market value for year *"t"*

V_{t-1}^* = previous appraised value made in the year *"t-1"*

ω = fraction between 0 and 1 (representing a measure of the appraiser's degree of confidence in the current valuation)

The intuition behind this model is relatively straightforward. When ω is closer to 1 (i.e. little weight placed on the previous appraisal), the appraiser is forward looking and the value is hypothetically closer to the true value. The potential, however, for large errors also exists if he is wrong. When ω is closer to 0, too much weight may be attached to the previous appraised value and not enough on the current true market value.[12] The appraiser must strike a balance somewhere between the two extremes. In uncertain times with a riskier and more volatile market, he is more likely to place more emphasis on the previous appraisal.

The smoothing that results from this appraisal behavior also increases the positive autocorrelation of the index return series.[13] Autocorrelation of a time series measures the correlation of the series with itself. When present, the value at a given point in time is not independent but related to the value in some previous period. The appraisal model above demonstrates the clear relationship between present and past appraised values. A series with autocorrelation is said to display inertia or a certain degree of predictability.[14]

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[12] See Geltner (1993a), p. 328.

[13] *Ibid.*, p. 328.

[14] When autocorrelation is present in a times series, the Classical Linear Regression model is violated. This results in the OLS line providing a better fit to the data than the actual true relationship. The R^2 is overestimated and variance is underestimated. A readable discussion on this topic is contained in Kennedy (1992), pp. 113–116 and 119–124.

In periods when real estate prices are falling, there may be additional subtle pressure on the appraiser to adjust market values only partially. The appraiser is typically hired by a property investment manager whose compensation may be linked in part to the appraised property value. Since the appraiser may be interested in future work from the manager, an incentive to limit the amount of the reported loss potentially exists. When this occurs appraised values will slowly ratchet downwards, lagging actual market values.[15]

It should be noted that the intent of the above discussion is not to lay blame on the appraisers' doorstep. It is solely intended to illustrate certain effects inherent in the construction of appraisal–based returns time series which result in underestimating volatility. Unless corrected for, the usefulness of the series is impaired when performing hedge ratio regressions, when used as a benchmark for asset allocation models or when used in any analysis where a true measure of the volatility is required.

2.2 Index Smoothing at the Aggregate Level

A further problem arises when the individual properties are aggregated at the index level. Even assuming appraisals at the individual level which represent true market values, temporal aggregation also results in smoothing the variance/volatility of the time series. The definition of temporal aggregation is:

> " ...the use of spot valuations of properties occurring over an interval of time to impute the spot value of a property or of a real estate value index as of a single point in time."[16]

Properties in an index are typically appraised at different points in time. These spot valuations are, however, averaged together to produce the index value for the particular period in question. When this occurs, the resulting index value attributed to that period will be a moving average of the spot valuations. This averaging results in additional smoothing of the index.

[15] See Geltner (1993a), p. 344.
[16] See Geltner (1993b), p. 141.

2.3 The Russell–NCREIF Property Index

The Russell–NCREIF Property Index (RNI) has tracked the performance of institutional grade commercial property returns in the United States since its inception in the fourth quarter of 1977. The weighted index is compiled by the Frank Russell Co. and is based on reports filed by member firms of the National Council of Real Estate Investment Fiduciaries (NCREIF). It tracks the historical performance of income–producing properties which are owned either by commingled funds for qualified pension and profit–sharing trusts or by the trusts directly and managed on a separate account basis. The index is made up of unlevered properties (properties owned free of debt or with less than 5 percent leverage) and represents the largest database of commercial real estate in the country. At the end of 1994 it contained 1,558 properties with an appraised market value of $23.5 billion.[17]

The RNI, which covers a wide spectrum of property types and geographical regions, is divided into total returns and sub–indices as follows:

1. Total Returns:	National
2. Regional Indices:	East, Midwest, South and West
3. Division Indices:	East North Central, Mideast, Northeast, Southeast, Southwest, Mountain, West North Central and Pacific
4. Property Type:	Apartment, R&D Office, Office, Retail and Warehouse
5. Region/Property Type:	East, etc./Apartment, R&D Office, Office, Retail and Warehouse

Returns are computed based on the period–to–period percent change in the index with both the income and capital value components reported separately each quarter. The income component represents such items as rents received, while the capital value component represents the appraised property value. For this study, we are concerned only with the capital value component. Note that the income component is fairly steady over time and is a reported value, so appraisal smoothing with this component is not an important issue.

[17] National Council for Real Estate Investment Fiduciaries, "The Russell–NCREIF Real Estate Performance Report."

The total return for each quarter is computed as follows:

$$Period\ returns = \frac{P_t - P_{t-1} + PS - CI + NOI}{P_{t-1} + 0.5(CI - PS) - 0.33NOI} \qquad (2b)$$

Where:

P_t = Appraised value in period "t"

P_{t-1} = Appraised value in period "$t-1$"

PS = Any distributions of cash from property sales

CI = Additional capital investments made for improvements

$0.5(CI - PS)$ = Midpoint assumption to account for any net cash inflow (outflow)

$0.33NOI$ = Reflects monthly receipt of income from tenant leases

The capital value returns are computed by omitting the income component out of the above equation.

2.4 Inferring True Returns from the RNI

Although the RNI is probably the most widely used commercial property index in the United States, there is widespread agreement among both academics and practitioners that problems exist with its accuracy. Since it is an appraisal–based index, as previously noted, volatility is significantly underestimated. The variance from appraisal–based returns display smaller absolute values than those of true returns.[18] The RNI values, if not adjusted, suggest that less risk is present than actually exists. The returns series also appear to lag the market, with price movements preceding the index by several periods. The large declines in property values in the late 1980s were not captured by the RNI until well after they had occurred. The reported capital component of the total RNI is shown in Figure 2.1. Large declines in the index are not evident until the 3rd quarter of 1990. This is at odds with what was experienced in the industry: many financial institutions began running into problems as a result of falling property prices several years prior to that date.

[18] See Geltner (1989b), p. 338.

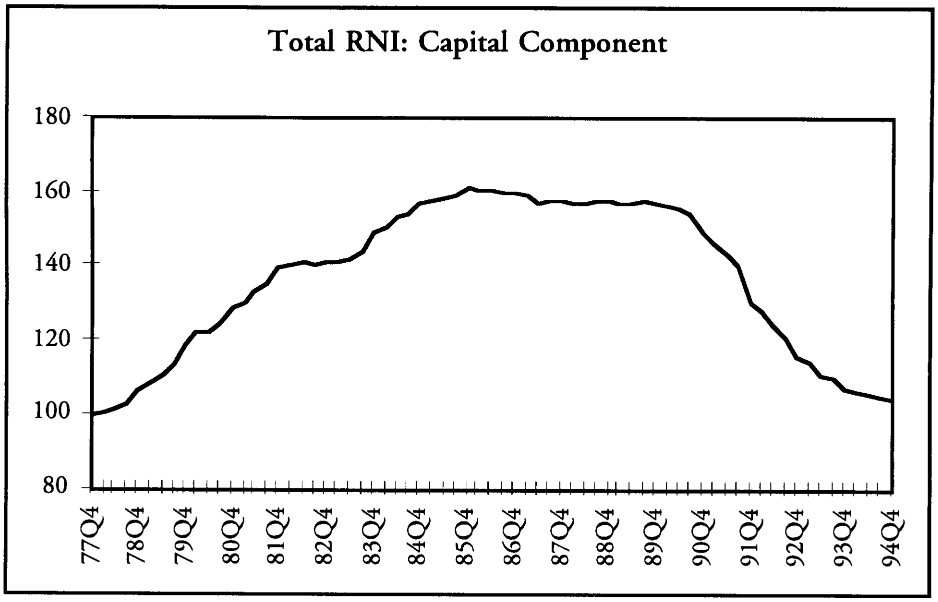

Figure 2.1

Several academic studies have been carried out in which stochastic analysis and econometrics have been used with appraisal–based series in order to derive quantitative information about the true returns and generate a simulated series of historical market values.[19] The aim of these studies is summarized as follows:

> "When carefully used, appraisal–based returns data may eventually offer the possibility of raising the scientific level of the financial economic study of real estate assets to a level more commensurate with that of other asset classes."[20]

2.5 Unsmoothing the Russell–NCREIF Index

The goal in unsmoothing the RNI is to recover the true returns and volatility from the series. In order to accomplish this, a model has been hypothesized by academics which accounts for the appraisal behavior previously cited: (1) appraisal smoothing at the individual property level and (2) temporal aggregation. A third factor that we have not yet discussed, reappraisal seasonality, is also incorporated into the model.

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[19] See Geltner (1989a–c), Geltner (1991a–b), Geltner (1993a–b) and Fisher, Geltner and Webb (1994).
[20] See Geltner (1991a), p. 342.

Equation (2a) can be rewritten as:

$$r_t^* = \omega_0 r_t + \omega(B) r_{t-1} \tag{2c}$$

where r_t^* is the smoothed RNI period t return, r_t and r_{t-1} are the unsmoothed returns and $\omega(B)$ is a polynomial function in the lag operator, B. It follows that the unsmoothed RNI return can be represented by an autoregressive model having the form:

$$r_t^* = \phi(B) r_{t-1}^* + e_t \tag{2d}$$

where $\phi(B)$ is a lag operator polynomial of the form:

$$\phi(B) = \phi_1 + \phi_2 B + \phi_3 B^2 + \ldots \tag{2e}$$

and e_t is given by:

$$e_t = \omega_0 r_t \tag{2f}$$

By inverting Equation (2c), the unsmoothed returns, which cannot be observed, can be expressed as a function of the present and past appraised returns, which can be observed:

$$r_t = \frac{1}{\omega_0}\left[r_t^* - \phi(B) r_{t-1}^*\right] \tag{2g}$$

Fisher, Geltner and Webb (1994) then imposed a volatility condition on the model by assuming that the quarterly volatility of the unsmoothed returns equals one–half the volatility of the S&P 500. Although ad hoc, this is consistent with consensus among practitioners within the industry regarding the volatility of real estate.

$$\omega_0 = 2\frac{\sigma_{(r_t)}}{\sigma_{S\&P500}} \tag{2h}$$

While appraisals occur throughout the year, in general more properties are appraised in the 4th quarter than in the other three quarters combined. This introduces fourth–order autocorrelation into the RNI returns series.[21] Whenever the index is moving in one direction or the other, this fourth–quarter appraisal dominance results in the fourth–quarter index returns to be of a greater absolute magnitude relative to the previous three quarters in the calendar year. Therefore, a fourth–quarter AR coefficient is included in the model in addition to the first–order AR coefficient.

The resulting equation for unsmoothing the total RNI is as follows:

$$r_t = \frac{1}{\omega_0}\left[r_t^* - z_1 r_{t-1}^* - z_4 r_{t-4}^*\right] \quad (2i)$$

The parameter values may now be estimated empirically, assuming random true returns, by applying standard univariate time–series estimation procedures to the RNI return data (see equation (2d)). Once the parameters values on the observed values have been estimated, they are inverted to yield the true returns.

2.6 The Total Russell–NCREIF Index Unsmoothed

Using this procedure detailed, the total index was unsmoothed as follows:

1. The index time series from was provided by the Frank Russell Company. The series consisted of quarterly relative returns from 1978 to 1994. The relative returns of the capital appreciation component of the index were converted to quarterly period returns.

   RNI Quarterly Return (78Q1) = (1.0072 – 1)(100) = 0.725%

2. The quarterly appreciation returns were then adjusted for inflation by subtracting out the corresponding period rates from the Consumer Price Index.

   Adjusted RNI Quarterly Return (78Q1) = 0.725% – 1.988% = –1.262%

[21] See Geltner (1993a), p. 329.

3. The adjusted quarterly returns were regressed on adjusted quarterly returns lagged one and four quarters. The equation resulting from the regression (with the t–statistics for the two variables shown in parentheses below) is:

$$r^*_t = -0.3193 + \underset{(1.92)}{0.1892 r^*_{t-1}} + \underset{(5.93)}{0.5848 r^*_{t-4}}$$

4. The equation for the unsmoothed quarterly returns, r_t, is given by:

$$r_t = (1/\omega_0)(r^*_t - 0.1892 r^*_{t-1} - 0.5848 r^*_{t-4})$$

5. ω_0 is calculated using the standard error of the estimate (SEE) from the regression and assuming that the volatility for the property returns is one–half the volatility of the S&P 500.

SEE = 1.2002%; Standard Deviation of the S&P 500 = 7.6%

$$\omega_0 = (2)(0.012) / 0.076 = 0.3158$$

6. The full equation for the unsmoothed quarterly returns is:

$$r_t = (1/0.3158)(r^*_t - 0.1892 r^*_{t-1} - 0.5848 r^*_{t-4})$$

7. Because a four quarter lag is used in the equation, the first quarter for which an unsmoothed return can be calculated is the first quarter of 1979.

$$r_{1979Q1} = 3.167\ (-1.364\% - (0.1892)(2.040\%) - (0.5848)(-1.262\%)) = -3.204\%$$

Adding back in the CPI quarterly inflation rate of 3.06% gives a real return of –0.144%.

8. The unsmoothed total RNI can now be calculated. With the 78Q4 unsmoothed index value set equal to 100, the value for the first quarter of 1979 is:

79Q1 unsmoothed index value = 100 + (–0.144/100)(100) = 99.86

Both the reported index and the unsmoothed index are shown in Figure 2.2. Although basically similar in shape, the unsmoothed index displays more volatility than the reported index. It would appear that, in general, the reported index values lag the true returns by approximately one year. The unsmoothed values suggest that true returns peaked in the 2nd quarter of 1984. From that point on, returns from commercial properties basically fell. This is consistent with what transpired in the industry, with the failure of a large number of financial institutions attributed to the drop in real estate prices over this period. In contrast, the reported (smoothed) index rose until the 4th quarter of 1985. Smoothed values then declined slightly until the 3rd quarter of 1991, at which point they began a steep drop which did not start to level out until the 4th quarter of 1993. The unsmoothed index suggests that the bottom of the market was reached in the 3rd quarter of 1993 and that returns have begun to appreciate again. This is also consistent with the anecdotal evidence in the industry.

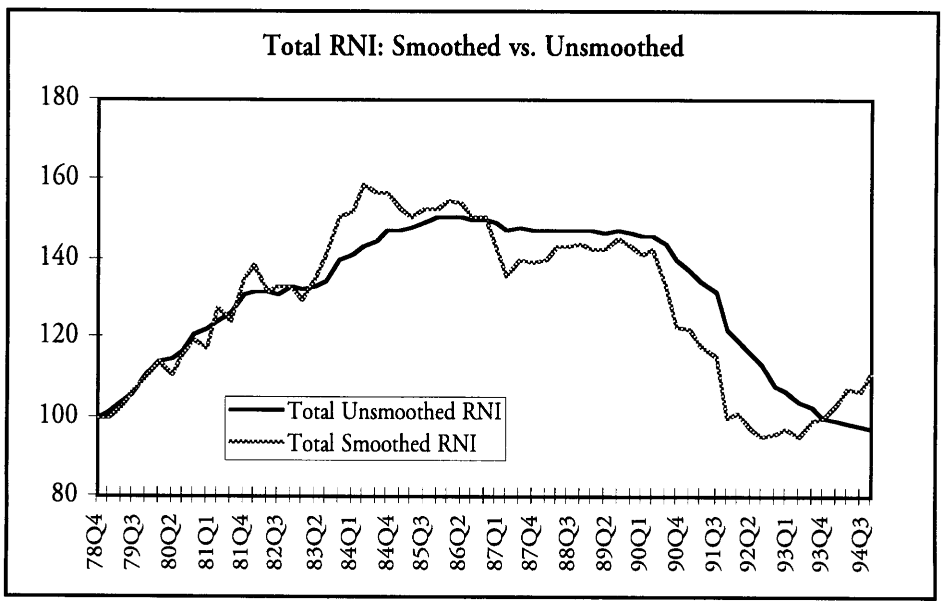

Figure 2.2

2.7 Unsmoothing the Russell–NCREIF Sub–Indices

In order to obtain additional returns series for the hedging analyses, the regional, divisional and property type sub–indices, as well as four of the regional/property type sub–indices, were unsmoothed using the method employed for the total national index. One potential problem has to do with the ad hoc volatility constraint. A figure equal to one–half the volatility of the S&P 500 was used in all cases. This may be valid at the national index level, which enjoys the benefits of complete geographic and property type diversification. At the sub–index level, however, it is possible that volatilities may be higher. This would affect the magnitude, but not the general direction, of the hedging results.

The unsmoothing did bring out the fact that the significant lag periods for each sub–indice was different. Unlike the total RNI, where the 1st and 4th period lags matter, the sub–indices' lags displayed considerable variety. Tables containing the lag information and the derived unsmoothing equations for the sub–indices as well as miscellaneous correlation matrices are provided for information in Appendix A.

Chapter 3: Hedging

Comprehensive risk management programs involve identifying the risks inherent in a given business. These may include credit risk, legal risk, administration risk, market risk and price risk. Certain risks are unique to a particular industry. For example, asset/liability mismatch problems are a risk faced by insurance companies and Savings & Loans. They are a business risk rather than strictly a financial risk for these industries. In this study we shall be concerned only with financial risk, or the risk that a financial asset might experience some change in value over the period of time that it is held by the investor. In low volatility environments, this is generally not a problem. Price movements are small and the risk of large changes is negligible. In this case there may be little rationale to hedge: the costs may outweigh the benefits. When volatility increases, however, the risk of large losses as well as gains increases. In such an environment investors can benefit from financial instruments with which they can hedge away a portion or all of the risk to which they are exposed.

3.1 Hedging Basics

The risk profile that characterizes the situation faced by an investor holding a long (owning) position in an asset such as real estate is shown in Figure 3.1. In this model, the price–value/profit relationship is shown as linear. Note that this simple relationship may not necessarily hold in the real world. The positive slope indicates that value (or profit) rises in tandem with rising prices and falls when prices decline.

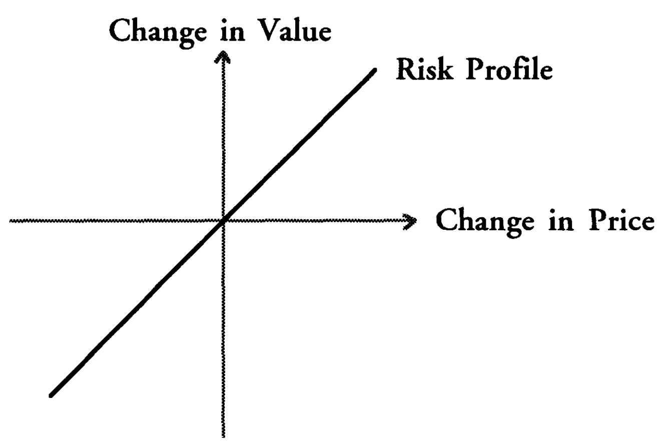

Figure 3.1

If a financial instrument can be found that has a similar payoff profile to the asset held, establishing a short (selling) position will protect the investor against falling prices. In Figure 3.2, the payoff profile from the short position has been superimposed onto the payoff profile from holding the asset. It can be seen that when the slopes of both lines are equal in magnitude, but different in sign, the payoff under any scenario is exactly zero. When prices fall, the loss on the asset is offset by the gain on the short position. When prices rise, the exact opposite occurs. The risk associated with price movements (both positive and negative) is completely eliminated. In this case, the asset is said to be perfectly hedged.

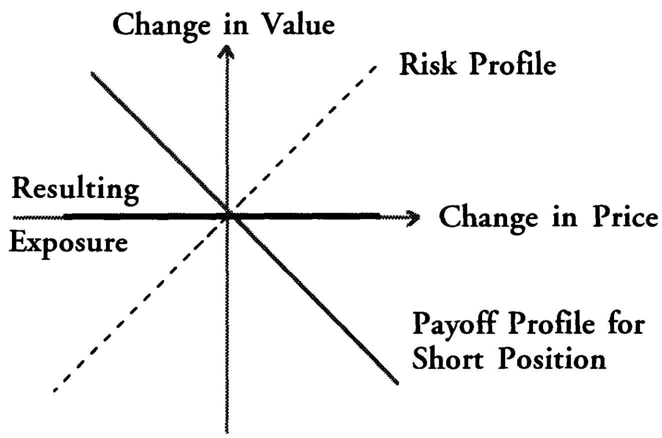

Figure 3.2

There is a clear relationship in Figure 3.2 between the changes in price or returns on the asset being hedged and the asset underlying the futures contract. In this particular case, the two are perfectly correlated. When two assets exhibit similar price movements, taking opposite positions in the two results in neutralizing these movements.

Hedging reduces risk. As mean–variance portfolio theory demonstrates, reducing risk also serves to reduce expected returns. The investor initiating the hedge must determine the degree of risk to which he wishes to be exposed. As can be seen in Figure 3.2, the perfect hedge results in canceling out any upside benefit for the investor as well as immunizing him from any downside risk.

In order to hedge, the precise effect of price change on profits must be known. Ideally the relationship between the two assets should be linear. Non–perfectly correlated relationships are somewhat more difficult to deal with. Lastly, suitable contracts must be available for the hedging security which minimize both asset mismatch and maturity mismatch. When the security used for the hedge is different from the asset held, one has an asset mismatch. Hedging with different instruments is termed cross hedging. With asset mismatch, the correlation between price movements is not perfect. The greater the difference between two assets, the less certain the relationship between their respective prices. If the two display no correlation, hedging could actually add risk rather than reduce it since price movements between the two are not related at all. A maturity mismatch results when there is a difference between the date when the hedge is to be closed out and when the security used in the hedge matures. These mismatches give rise to what is termed basis risk. In simple terms, the greater the basis risk, the more uncertain is the effectiveness of the hedge.

Financial instruments available for hedging include forward and futures contracts, options and swaps. Forward and futures contracts obligate the purchaser/seller to buy/sell the underlying asset on a given date at a specified price. Option contracts, on the other hand, provide the right, but not the obligation, to buy or sell the underlying asset. When used singly, the payoff from options is uni–directional, allowing the holder of the option to take advantage of price movements in a certain direction. Ideally, a participant in the market would like to capture the upside benefits in a rising market while neutralizing the downside risk in a declining market. Hedging strategies with options permit this. Secondary markets for both futures and options are maintained by the various exchanges in this country. Swaps are agreements between two parties to exchange future cash flows according to some set formula. Swaps are typically traded over–the–counter by a financial intermediary such as a bank.[22]

This study shall be limited to models which replicate futures contracts. Swaps have not been included since they are not actively traded. Although a large market for options exists, they have not been included since their structure and pricing mechanism is somewhat different. Possible hedging strategies utilizing options, however, can be inferred from the results found using futures contracts.

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[22] For an in–depth study of these instruments and hedging, the reader is referred to Cox and Rubinstein (1985), Daigler (1993), Hull (1993), Siegel and Siegel (1990) and Smithson, Smith and Wilford (1995).

3.2 Determining the Hedge Ratio

For the investor who is long the asset, the hedge ratio is the number of futures contracts to sell short per long position. For the investor who is short the asset, it is the ratio of the number of futures contracts to buy long per short position.

For the following, we shall assume that an investor owns an asset and wishes to hedge his position. The mean–variance approach is used to determine the optimal hedge ratio for the short hedge. The assumption is made that the optimal combination of cash position and futures contracts is the one whose variance is minimized The optimal hedge ratio is the one that minimizes the variance (risk) of changes in the expected return to the investor.[23]

For the hedged position, the expected change in value is given by:

$$E[\Delta P] = x_s E[\Delta P_s] - x_f\left[\Delta P_f\right] \quad (3a)$$

and the variance given by:

$$VAR(\Delta P) = x_s^2\sigma_s^2 + x_f^2\sigma_f^2 - 2x_s x_f \sigma_{sf} \quad (3b)$$

Where:
- x_s = Spot Market Holding
- x_f = Futures Market Holding
- ΔP_s = Price Change in the Spot Market
- ΔP_f = Price Change in the Futures Market
- σ_s^2 = Variance of Spot Market Holding
- σ_f^2 = Variance of Futures Market Holding
- σ_{sf} = Covariance of the Spot Market Holding with the Futures Market Holding

Let the hedge ratio $h^* = x_f/x_s$. The investor shorts a fraction of his long position, h^*, in the futures markets and leaves $\left(1-h^*\right)$ unhedged.

[23] See Hull (1993), p. 38.

The expected change in value can now be rewritten as:

$$E[\Delta P] = E[\Delta P_s] - h^* E[\Delta P_f] \quad (3c)$$

and the variance the hedged position is:

$$VAR(\Delta P) = \sigma_s^2 + h^{*2}\sigma_f^2 - 2h^*\sigma_{sf} \quad (3d)$$

where the covariance $\sigma_{sf} = \rho\sigma_s\sigma_f$ (ρ is the correlation coefficient between change in value on the asset/spot position and the futures contract).

Taking the derivative gives:

$$\delta v/\delta h^* = 2h^*\sigma_f^2 - 2\sigma_{sf} \quad (3e)$$

Setting the derivative equal to zero and noting that the second derivative is positive, the hedge ratio that minimizes variance is therefore:

$$h* = \sigma_{sf}/\sigma_f^2 = \rho\sigma_s/\sigma_f. \quad (3f)$$

Note that this is exactly the same as the definition of the beta of a stock.

In plain terms, the optimal hedge ratio derived under the mean–variance approach can be described as:

1. The covariance of the spot and futures price changes divided by the variance of the futures returns, or

2. The product of the correlation between the spot and futures price changes and the standard deviation of the spot price changes divided by the standard deviation of the futures price changes.

The variance of returns for the minimum risk hedge is:

$$\sigma_{\min}^2 = \sigma_p^2(1-\rho^2) \quad (3g)$$

An alternative method for calculating the optimal hedge ratio is by OLS regression. The hedge ratio is the slope of the best fit line resulting from the regression. The slope coefficient from an OLS regression is exactly the same as Equation (3f).

The R^2 from the regression measures the proportion of the total volatility explained by the independent variables in a regression. Its magnitude indicates the effectiveness of the hedge or, in other words, the proportion of risk that one is able to get rid of by entering into the hedge.

$$R^2 = \frac{Systematic\ Risk}{Total\ Risk} = 1 - (Residual\ Risk / Total\ Risk) \tag{3h}$$

Hedging can reduce systematic risk. The non–systematic, or residual, risk that remains is called basis risk. The Standard Error of the Regression is the standard deviation of the residuals from the regression line. It represents the standard deviation of the residual risk that remains after the systematic risk has been hedged out.

Chapter 4: Real Estate: Links with the Public Equity Markets

What relationships, if any, exist between the public equity markets and private commercial real estate equity in the United States? Real estate equity would be expected to have some stock–like characteristics, with economic factors include in its pricing.[24] If the nation's stock markets reflect the underlying strength of the economy, one could make the supposition that any such strength or weakness would be reflected in commercial real estate returns as well. This may not necessarily be the case, however, since the real estate market is subject to a separate set of complex supply and demand side influences which are constantly changing. Are there times when real estate behaves more like the market? When are they linked and why?

Long–term interest rates have a large impact on the real estate market. A rise in interest rates reduces the yield from real estate and makes new issues of fixed income securities more attractive to investors.[25] Given this sensitivity to interest rate levels, there could be occasions when real estate tends to act more like a bond than a stock. The debt, or mortgage component displays the same inflation risk characteristics of a bond.[26] Since the RNI contains only properties which are unlevered, our interest is primarily with the equity markets, although we have included 10 year Treasury Notes and 30 year Treasury Bonds in the set of our potential hedging instruments for the hedging analyses detailed in the following chapters.

In this chapter we shall examine the relationships between stock market indices and the unsmoothed Russell–NCREIF Index. It is important to note that this is predicated on the assumption that the unsmoothed returns series, calculated as per the method detailed in Chapter 2, do represent the true returns for private commercial real estate. Also note that in all instances where we refer to the RNI from this point forwards, we shall be referring to the unsmoothed returns series if it does not specifically say so.

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[24] See Ibbotson and Siegel (1984).

[25] For those investors already holding fixed income securities, rising interest rates cause a decline in the price of the securities.

[26] *Ibid.*, p. 221.

4.1 Public Equity Market Indices

The following four indices were used as proxies for the public equity markets in the United States:

1. S&P 500 Index
2. Russell 2000 Index (R2000)
3. Value Line Index (VL)
4. Wilshire Small Cap Index (WSC)

The S&P 500 is a diversified index of 500 companies traded on the New York Stock Exchange. The market value of the index equals roughly 80 percent of the value of all stocks listed on the exchange. The R2000 represents the lower two–thirds of the 3,000 largest publicly listed companies in the country. The VL is an equally weighted geometric average of 1,700 common stocks. Lastly, the WSC represents 250 companies with a capitalization less than $919 million.[27] Futures and options contracts for all four indices are actively traded on the exchanges.

Data for the S&P 500 and the R2000 included quarterly returns from the 1st quarter of 1979 through the 4th quarter of 1994, for a total number of 64 observations. Quarterly data obtained for VL commenced the 1st quarter of 1989, for a total number of 24 observations, while 32 quarters were available for the WSC, beginning the 1st quarter of 1987.

Cross–correlation coefficients for returns on the equity indices and the unsmoothed RNI sub–indices are shown in Table 4.1.[28] At the national level, virtually no correlation was found to exist between the total RNI and the four equity indices. Cross–correlations ranged from –0.06 for the S&P 500 to 0.13 for the VL. Marginally stronger cross–correlations were found at the regional level than those at the national level. Although still quite weak, the RNI East/WSC series displays the strongest relative correlation, with a value of –0.26. The highest positive value is the 0.18 for the RNI South/R2000 series. All of the correlations between the RNI East and the four equity indices were negative, while

[27] The 250 companies are chosen from the most liquid of the 1,750 companies ranked by size after the largest 750 companies in the United States.

[28] Cross–correlation coefficients with the sub–components of the NAREIT index are also included for information. NAREIT stands for the National Association of Real Estate Investment Trusts.

the opposite was true of the RNI South. The RNI Midwest and West were predominately negatively correlated with the indices, although the values are small enough to essentially be meaningless.

Correlation Coefficients: Equity Indices and the RNI Indices	S&P 500	Russell 2000	Value Line	Wilshire Small Cap	NAREIT All	NAREIT Equity	NAREIT Equity**	NAREIT Mortgage
Total RNI	-0.06	0.06	0.13	0.02	0.12	0.10	0.19	0.07
By Region:								
East	-0.20	-0.20	-0.05	-0.26	-0.13	-0.15	-0.09	-0.07
Midwest	-0.09	0.06	-0.09	-0.13	-0.03	-0.15	-0.09	-0.07
South	0.06	0.18	0.09	0.11	0.20	0.18	0.25	0.17
West	-0.09	-0.01	0.01	-0.04	0.03	0.04	0.11	-0.06
By Division:								
East North Central	-0.06	0.04	-0.12	-0.14	-0.07	-0.07	0.02	-0.18
Mideast	-0.06	-0.01	0.21	-0.12	-0.07	-0.10	-0.05	0.02
Mountain	0.12	0.22	0.24	0.26	0.21	0.17	0.25	0.19
Northeast	-0.19	-0.18	-0.16	-0.31	-0.20	-0.17	-0.10	-0.18
Pacific	-0.17	-0.09	-0.03	-0.10	0.01	0.02	0.08	-0.10
Southeast	-0.04	0.06	0.18	0.05	0.08	0.06	0.15	0.10
Southwest	0.13	0.22	0.05	0.16	0.21	0.20	0.21	0.14
West North Central	-0.13	0.06	0.00	-0.21	0.06	0.05	0.12	0.03
By Region & Property Type:								
West:Office	-0.04	-0.02	-0.03	-0.03	0.08	0.10	0.15	-0.02
West:R&D Office	-0.08	-0.09	-0.27	-0.29	-0.08	-0.07	-0.06	-0.05
West:Retail	0.06	0.15	0.28	0.09	0.08	0.04	0.12	0.14
West:Warehouse	-0.01	-0.01	0.08	-0.03	0.11	0.13	0.14	-0.07
By Property Type :								
Apartment	0.06	0.20	0.03	-0.06	-0.10	-0.16	-0.06	0.04
Office	-0.07	-0.07	-0.09	-0.11	0.06	0.06	0.13	-0.03
R&D Office	-0.04	-0.04	-0.07	-0.17	0.07	0.06	0.10	0.03
Retail	0.13	0.13	0.32	0.07	0.10	0.04	0.11	0.23
Warehouse	-0.05	0.04	0.13	-0.04	0.10	0.12	0.16	-0.06

NAREIT Equity** : Excluding Health Care

Table 4.1

Division cross–correlations range from a low of –0.31 for the RNI Northeast/WSC series to a high of 0.26 for the Mountain/WSC returns. The Northeast and Pacific divisions are negatively correlated with the indices. Positive correlation, on the other hand, is displayed by the Southwest and Mountain divisions. The remaining divisions all have a combination of the two.

In analyzing the most detailed sub–index of the RNI, the West Region/Property Type indices were used due to the fact that they contain the largest number of properties at this level. West/Office correlations are all positive, but again the values are so close to zero that they are insignificant. Correlations for West/R&D Office are all negative and display the strongest correlation seen in this subset with a –0.29 for the WSC. West/Retail correlations are all positive, with a maximum of 0.28 with the VL. The sign of the West/Warehouse correlations varies, but the values are insignificant.

Correlations at the Property type level were primarily weak, ranging from a low of –0.17 for R&D Office/WSC to a high of 0.32 for Retail/VL. Values for both Office and R&D Office were all negative, while positive for Retail. Apartment and Warehouse varied.

OLS regressions were run for all combinations which displayed a correlation coefficient having an absolute value equal to or greater than 0.20. The time periods examined spanned the entire period for which data was available: 79Q1 to 94Q4 for the S&P 500 and the R2000, 87Q1 to 94Q4 for the WSC and 89Q1 to 94Q4 for the VL. The regression results are shown in Table 4.2. As can be seen, in no case was the adjusted R^2 greater than 0.06 for any of the series analyzed.

Over these specific periods, no connection between the equity markets as a whole and the private equity property markets is demonstrated. This may be due in part to "efficient market" differences between the two. As compared to equity markets, property markets may be somewhat less efficient, which suggests that they may continue to lag equity markets even after correcting for appraisal smoothing. A more likely reason is that the two markets respond, to a large degree, to different supply and demand fundamentals.

In order to see whether there are any shorter periods during which the markets are more closely linked, the R2000 was regressed on the total RNI using a moving window which included two and four year observations. The results are shown in Table 4.3. There is some evidence of a relationship between the two over the shorter time periods examined, particularly for the periods 1984 to 1985 and 1992 to 1993. The problem, from a statistical point of view, is that the number of observations is limited using quarterly data. There may be shorter periods, such as a year, when the two are closely linked. It is not possible, however, to draw any definitive conclusions with only four data points.

4.2 Conclusions

Given the low correlations and the poor results from the regressions, the equity indices, by themselves, do not therefore appear to be suitable instruments for hedging the returns from commercial real estate. Over the time periods examined, there is little evidence of any strong relationships between the two markets.

Regression Results: RNI Indices on Equity Indices						
Returns Series	Period	Adjusted R^2	Coefficient	T–Statistic	Significance	D–W Statistic
East/S&P 500	79Q1 – 94Q4	0.03	-0.104	-1.64	0.107	1.90
East/R2000	79Q1 – 94Q4	0.03	-0.069	-1.62	0.111	2.62
East/WSC	87Q1 – 94Q4	0.04	-0.071	-1.49	0.145	1.49
Mideast/VL	89Q1 – 94Q4	0.00	0.060	1.00	0.327	1.39
Mountain/R2000	79Q1 – 94Q4	0.03	0.071	1.73	0.088	1.81
Mountain/VL	89Q1 – 94Q4	0.01	0.096	1.15	0.262	1.32
Mountain/WSC	87Q1 – 94Q4	0.04	0.080	1.49	0.146	1.33
Northeast/WSC	87Q1 – 94Q4	0.06	-0.072	-1.76	0.088	1.27
Southwest/R2000	79Q1 – 94Q4	0.03	0.076	1.77	0.082	1.74
West North Central/WSC	87Q4 – 94Q4	0.01	-0.086	-1.15	0.259	2.44
West:R&D Office/VL	89Q1 – 94Q4	0.03	-0.074	-1.30	0.209	1.91
West:R&D Office/WSC	87Q1 – 94Q4	0.06	-0.061	-1.68	0.103	1.97
West:Retail/VL	89Q1 – 94Q4	0.03	0.119	1.35	0.192	1.43
Apartment/R2000	79Q1 – 94Q4	0.02	0.007	1.60	0.114	1.70
Retail/VL	89Q1 – 94Q4	0.06	0.138	1.59	0.125	1.20

Table 4.2

Regression Results: R2000 on the Total RNI

Two Year Moving Window

From	To	R^2	T–Stat
79Q1	80Q4	0.13	(0.94)
80Q1	81Q4	0.02	0.34
81Q1	82Q4	0.05	0.58
82Q1	83Q4	0.05	(0.57)
83Q1	84Q4	0.11	(0.84)
84Q1	**85Q4**	**0.46**	**(2.26)**
85Q1	86Q4	0.00	0.16
86Q1	87Q4	0.01	(0.20)
87Q1	88Q4	0.01	(0.02)
88Q1	89Q4	0.13	0.96
89Q1	90Q4	0.25	1.41
90Q1	91Q4	0.06	0.62
91Q1	92Q4	0.09	0.77
92Q1	**93Q4**	**0.42**	**2.10**
93Q1	94Q4	0.12	(0.90)

Four Year Moving Window

From	To	R^2	T–Stat
79Q1	82Q4	0.01	0.28
80Q1	83Q4	0.00	(0.13)
81Q1	84Q4	0.00	0.13
82Q1	85Q4	0.08	(1.13)
83Q1	86Q4	0.05	(0.83)
84Q1	87Q4	0.05	(0.86)
85Q1	88Q4	0.01	(0.27)
86Q1	89Q4	0.01	0.27
87Q1	90Q4	0.03	0.69
88Q1	91Q4	0.07	1.03
89Q1	92Q4	0.10	1.22
90Q1	93Q4	0.10	1.22
91Q1	94Q4	0.00	(0.17)

Table 4.3

Chapter 5: Hedging the Total RNI Index

Movements in real estate prices are, in general, regional in nature. At any given time, certain sections of the country may be experiencing property booms, while in other areas the real estate industry is either flat or depressed. Although the health of the national economy is clearly a factor, real estate is affected to a much greater degree by regional economic performance. Given the strong regional forces at work, one of the aims of this study was to see whether it is possible to hedge commercial real estate returns on a national basis.

5.1 Static Hedging with Fixed Independent Variables

In order to evaluate whether hedging the total RNI returns is practicable, stepwise regressions were run with the total RNI returns series as the dependent variable and quarterly returns for twenty companies as the independent variables. In stepwise regressions, the independent variables are added into the model sequentially based on a rule in which R^2 is maximized. At every step, the variables incorporated in the previous steps are reexamined. With the addition of new variables, some of the variables that entered at earlier stages may become superfluous. The process continues until none of the remaining variables has a t–statistic with a significance level less than a specified cut–off level (no more variables can be added or removed).[1]

All of the companies used for this analysis are traded on the national exchanges. They cover a number of different industries which could be said to have a hypothetical connection with the real estate industry. Included were six utilities, two insurance companies, three large retailers, two banks, five REITs and lastly two equity indices, the S&P 500 and the R2000. A list of these companies is shown in Table 5.1.

Quarterly returns for these independent variables were obtained for the period from the 4th quarter of 1980 to the 4th quarter of 1994. The entire time series was used as a starting point for this initial exercise. It should be noted that this period is longer than what would be used in actual practice. The rationale behind using such a long time series was to determine the significant independent variables for the entire period ex post. These would

[1] For additional information see Kleinbaum, Kupper and Muller (1988) or Anderson, Sweeney and Williams (1994).

then be examined for hedging efficiency ex ante, *assuming that one would have been able to predict the variables and their coefficients at the beginning of 1981.*

Companies used in Stepwise Regressions for the Total RNI		
Utilities:	*Insurance Companies:*	*REITs:*
Allegheny Power System	Aetna	BRE Properties
Baltimore Gas & Electric	Travelers Corp.	Federal Realty
Carolina Power & Light	*Retailers:*	First Union
Northeast Utilities	K–Mart	MGI Properties
Ohio Edison	May Dept. Stores	Starwood Lodging
Pacific Gas & Electric	Winn–Dixie	
	Banks:	*Equity Indices:*
	Bank of Boston	S&P 500
	Bank of America	R2000

Table 5.1

The R^2 for the stepwise regression was 0.30. This was higher than was anticipated given the regional issues cited earlier. The significant independent variables from the regression for the 1981Q1 to 1994Q4 period included the following three utilities, one retailer and one REIT:

Company	Coefficient	T–Statistic
Allegheny Power	0.264	2.66
Ohio Edison	-0.163	-1.84[b]
Northeast Utilities	-0.105	-1.54[a]
K–Mart	-0.074	-1.94[c]
Federal Realty	0.225	3.30

[a] Significantly different from 0 at an 87% level of confidence
[b] Significantly different from 0 at a 93% level of confidence
[c] Significantly different from 0 at a 95% level of confidence

The effectiveness of hedging with these five companies was tested over the ten year period from 1985 to 1994. A static hedge was employed: static in the sense that the hedge ratios were kept constant over the entire duration of the hedge. The hedge involved shorting Allegheny Power and Federal Realty and taking long positions in the other three securities. A comparison of the efficiency of the hedge is shown in Figure 5.1. The graph displays the gains and losses experienced by both the hedged and unhedged portfolios on a theoretical property with a value equal to $1,565,300 on January 1, 1985.[2] Gains and losses, based on this initial figure, are shown in actual dollar amounts. As can be seen from the graph, hedging the total RNI using this strategy is partially successful. In all but two years, 1992 and 1993, the hedged portfolio reduced losses. In years when returns were positive, the hedged portfolio outperformed the unhedged total RNI. Note no allowance was made in the calculations for carrying costs or transaction costs for the hedged portfolio.

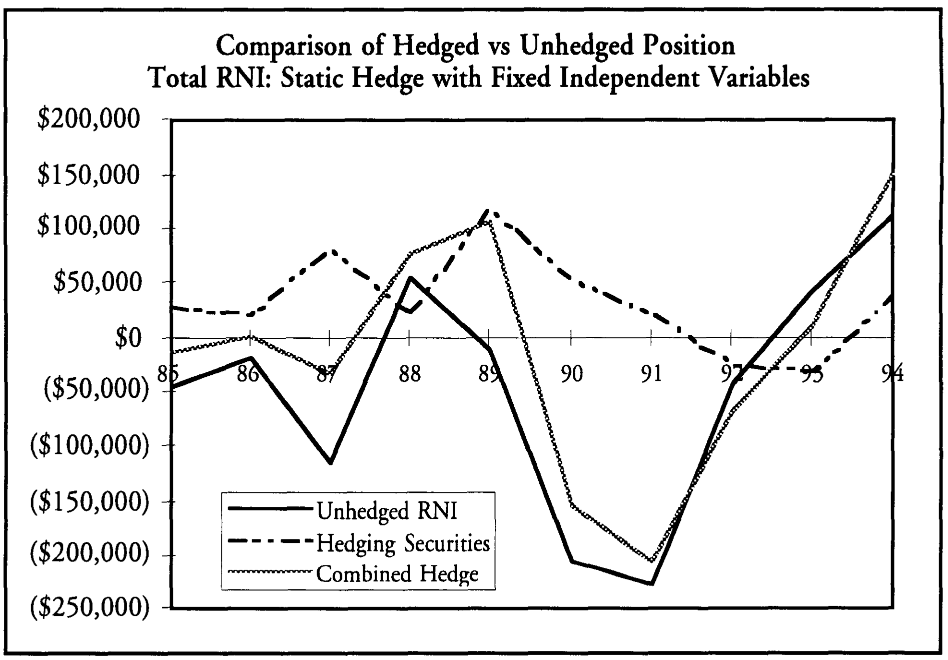


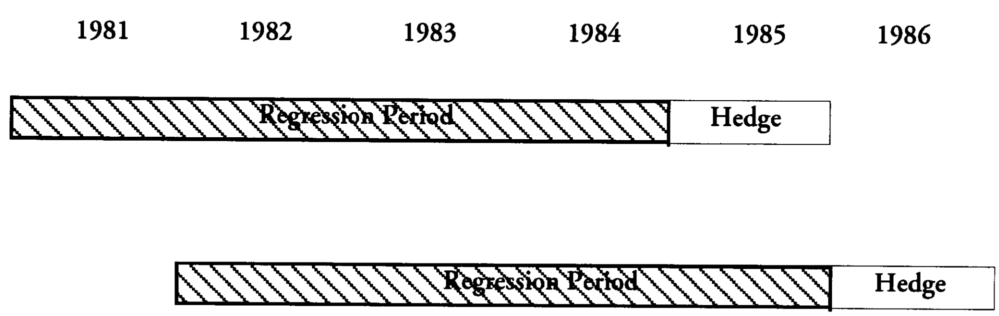
Figure 5.1

[2] This figure is equal to the value of the total unsmoothed RNI on that date times $10,000.

Although the NAREIT index is not a traded financial security, similar stepwise regressions were run for the period from the 3rd quarter of 1986 through the end of 1994 with the NAREIT equity index (excluding health care) included in the independent variables tested. The period examined is shorter than above due to the fact that the NAREIT data is only available commencing in 1986. The regressions were run to see what effect a traded REIT index would have, if any, on the ability to hedge the total RNI index during this period. The NAREIT equity index, however, was not found to be significant and its inclusion in the stepwise regression did not alter the previous results. This would tend to indicate that REITs, as a whole, behaved more like the stock market over the period examined than real estate. This might be due to the fact that some lag effects still appear to be present in the unsmoothed RNI.

5.2 Dynamic Hedging with Fixed Independent Variables

In order to test the stability of the relationship of these five variables with the total RNI, additional regressions were performed using a rolling window of 16 quarters of data. For example, the regression for the hedge to be instituted for the year 1985 included the observations from the 1st quarter of 1981 through the last quarter of 1984. The hedge for 1986 used observations from 1982 to 1985, and so on.



A 10 year period was investigated, running from the beginning of 1985 to the start of 1995. A dynamic hedging strategy was used, unlike the static hedge examined in Section 5.1. The hedge was rebalanced on an annual basis in accordance with the new hedge ratios determined by the regressions.

The results from these regressions are found in Table 5.2. Examination of the table demonstrates the inherent instability present in the relationship between this particular combination of equities and the total RNI over the period in question. R^2s ranged from a low of 0.12 at the end of 1988 to a high of 0.73 at the end of 1993, with the mean equal to 0.43 and standard deviation equal to 0.20.

The effectiveness of the hedge was assessed by its performance outside the sample period used for the regression analysis, projecting forward one year based on the results of the regression analysis for the preceding four year period. The results of this strategy are shown in the comparison of the hedged versus unhedged portfolios plotted in Figure 5.2.

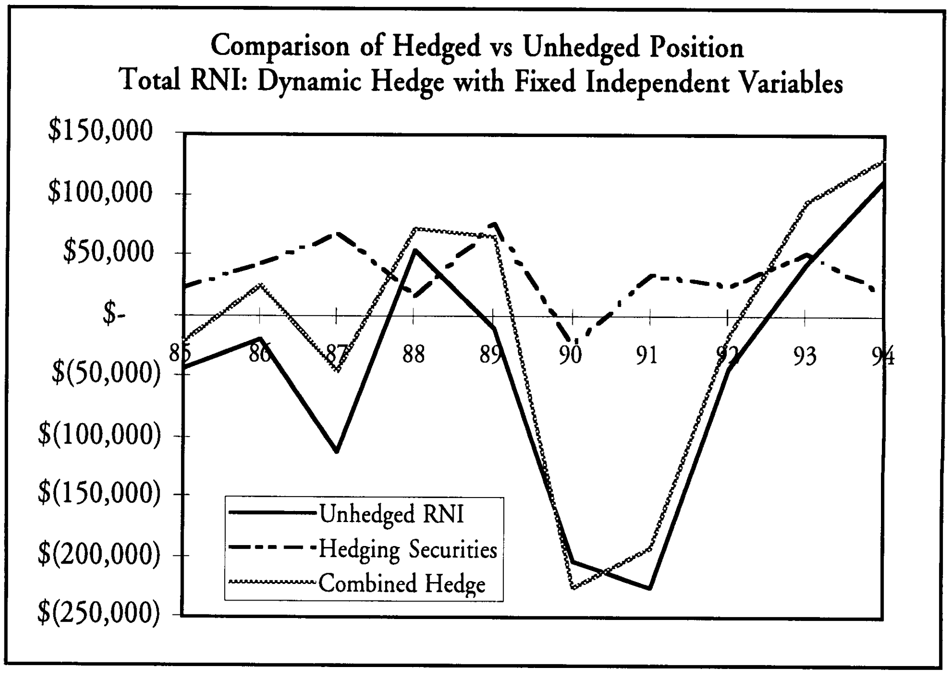


Figure 5.2

The results obtained, while not much different, are not quite as good as those found for the static hedge. This, however, is to be expected. The static hedge strategy was based on an unrealistic scenario in which the hedger had the advantage of complete knowledge of the returns series from 1981 to 1994 when instituting the hedge. In real life, knowledge of returns ex ante is not possible. This dynamic hedging strategy differed from the static hedge in that a forward–looking projection was made using the most recent 16 periods of data. While returns might be similar, it would be improbable that they would be identical. This gives rise to the difference witnessed between the results of the two strategies.

Regression Results: Total RNI on Fixed Variables

Regression Period	81:1 – 84:4	82:1 – 85:4	83:1 – 86:4	84:1 – 87:4	85:1 – 88:4	86:1 – 89:4	87:1 – 90:4	88:1 – 91:4	89:1 – 92:4	90:1 – 93:4	91:1 – 94:4
For Hedge in Year	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**
R^2	0.41	0.47	0.57	0.24	0.12	0.18	0.31	0.68	0.60	0.73	0.44
Adjusted R^2	0.11	0.21	0.35	-0.15	-0.31	-0.23	-0.04	0.52	0.41	0.60	0.17
Allegheny Power	0.272 (1.28)	0.028 (0.16)	0.157 (1.36)	0.061 (0.44)	0.063 (0.45)	0.152 (1.03)	0.280 (1.16)	0.397 (1.75)	0.165 (0.69)	0.102 (0.37)	-0.051 (-0.18)
Ohio Edison	-0.178 (-0.94)	-0.295 (-2.16)	-0.194 (-1.80)	-0.176 (-1.53)	-0.165 (-0.93)	-0.133 (-0.85)	-0.097 (-0.64)	0.090 (0.60)	0.048 (0.29)	-0.022 (-0.11)	-0.005 (-0.01)
Northeast Utilities	-0.105 (-0.39)	0.136 (0.61)	-0.077 (-.56)	0.071 (0.55)	0.046 (0.35)	0.004 (0.03)	-0.258 (-1.35)	-0.826 (-3.63)	-0.577 (-2.83)	-0.598 (-3.47)	-0.422 (-1.66)
K–Mart	-0.068 (-0.77)	-0.048 (-0.80)	-0.034 (-.84)	-0.034 (-0.65)	-0.030 (-.60)	-0.024 (-0.36)	-0.096 (-1.11)	-0.227 (-2.87)	-0.195 (-2.39)	-0.171 (-2.25)	-0.09 (-1.00)
Federal Realty	0.186 (1.35)	0.093 (0.75)	0.209 (1.86)	0.033 (0.24)	0.038 (0.27)	0.030 (0.16)	0.265 (1.57)	0.336 (2.65)	0.359 (3.08)	0.415 (3.81)	0.208 (1.72)

Table 5.2

This table lists the regression results for the dynamic hedge using fixed independent variables. The variable coefficients, which is equal to the hedge ratio, is shown for the periods examined. The related t –statistics are shown in parentheses below each coefficient.

5.3 Dynamic Hedging with Changing Independent Variables

Neither of the two strategies examined so far would be used in practice since they were based, either completely or in part, on assumed foreknowledge of ex post results. In this section we analyze a dynamic strategy which included changing both the independent variables as well as the hedge ratios used. This is a strategy which could be carried out in actual practice. The basis for this analysis was to see if it was possible to improve on the hedging results obtained above and to see to what extent the securities used in the hedge would vary, thereby arriving at additional information regarding the stability of these relationships.

The method used was similar to that used in Sections 5.1 and 5.2. In those sections, stepwise regressions were run for the total period of interest (1981 – 1994) and the significant independent variables found. These same variables were then used for hedging annual sub–periods within the total fourteen year period. For the new hedging analyzed, the variables were allowed to change based on the results of the regressions on each rolling 16 quarter window. In this way, the significant variables at the end of each window were identified and used for the hedge in the following year.

The number of independent variables considered for hedging purposes in a given year was limited to a maximum of five in order to restrain the number of parameters. This also has practical implications, since the greater the number of securities used for hedging, the higher are the associated transaction costs. A summary of the regression results is contained in Table 5.3. The significant independent variables found for each period are listed along with their respective coefficients. The R^2s and adjusted R^2s from the regressions are also shown. As can be seen, R^2s ranged from 0.38 to 0.94. The mean value was 0.79, with a standard deviation equal to 0.17.

The comparison of the hedged versus unhedged positions is shown in Figure 5.3. Three variables were used in the hedged portfolio. Except for the first period hedged, when there was a wide disparity between the two portfolios, there is little difference seen between the hedged and the unhedged portfolio. Over the last eight periods, the movement between the two displays great similarity. The hedged portfolio is not successful in this case.

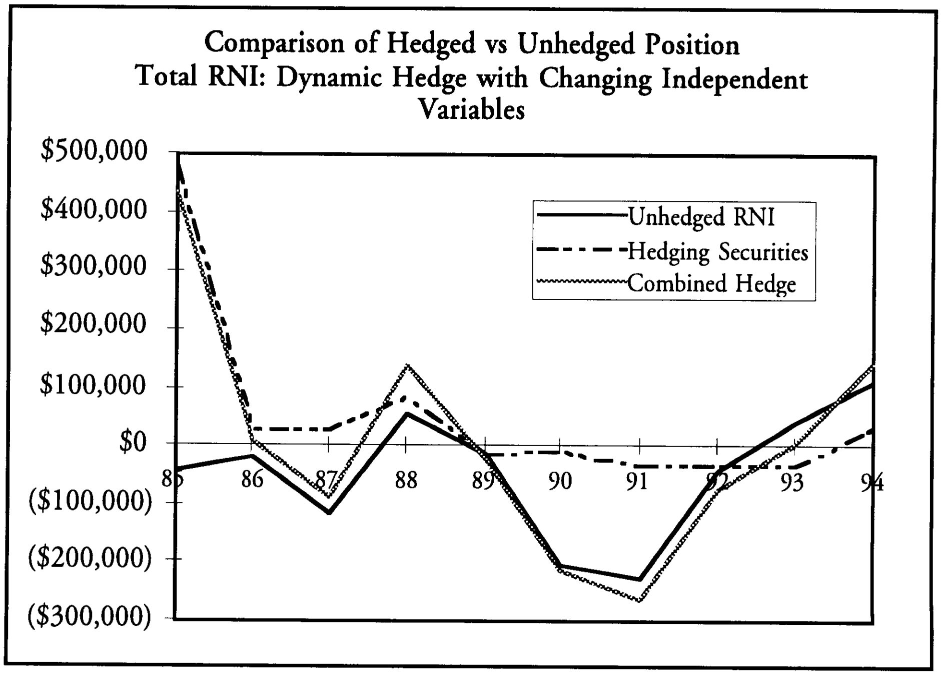


Figure 5.3

5.5 Conclusions

The results indicate that it is not possible to hedge movements in commercial property prices at the aggregate level nationally with equity securities. The analysis performed, however, was based on a very limited set of data. Inclusion of a much larger database might provide better results. A further refinement of this analysis would be to rebalance the hedge on a quarterly basis rather than annually. This also might provide better results, however these would have to balanced against the higher transaction costs and effort involved. Lastly, further studies might look at the optimal period to include in the regressions. It might be that 16 quarters is not the optimal number of observations. The best number may in fact vary in a manner associated with business cycles in the industries utilized.

Period	81:1 – 84:4	*Period*	86:1 – 89:4
R2	0.71	R2	0.63
Ohio Edison	-0.111	Bank of America	0.065
Pacific Gas & Electric	-0.253	Nordstrom	-0.038
BRE	0.505	Allegheny Power	0.223
S&P 500	-0.473	Winn–Dixie	-0.061
		First Union	-0.079
Period	82:1 – 85:4	*Period*	87:1 – 90:4
R2	0.82	R2	0.85
Ohio Edison	-0.210	Travelers Corp.	0.293
Baltimore Gas & Electric	0.374	K–Mart	-0.077
Pacific Gas & Electric	-0.286	MGI Properties	0.230
BRE	0.154	Banc One	-0.099
Bank of America	-0.079	Nordstrom	-0.090
Period	83:1 – 86:4	*Period*	88:1 – 91:4
R2	0.94	R2	0.92
Ohio Edison	-0.324	First Union	0.102
BRE	0.199	K–Mart	-0.405
First Union Realty	-0.205	Nordstrom	0.232
Allegheny Power	0.179	Northeast Utilities	-0.335
First Realty	0.131	Aetna Life	0.156
Period	84:1 – 87:4	*Period*	89:1 – 92:4
R2	0.79	R2	0.91
Nordstrom	-0.050	K–Mart	-0.146
Pacific Gas & Electric	0.109	May Department Stores	0.414
Carolina Power & Light	-0.600	Pacific Gas & Electric	-0.136
Northeast Utilities	0.534	Chemical Bank	-0.106
First Realty	-0.140	Aetna Life	-0.075
Period	85:1 – 88:4	*Period*	90:1 – 93:4
R2	0.38	R2	0.91
Bank of America	0.046	First Union	0.101
Nordstrom	-0.067	Northeast Utilities	-0.322
		Nordstrom	0.146
		Banc One	0.335
		Carolina Power & Light	0.366
		Period	91:1 – 94:4
		R2	0.80
		First Union	0.128
		Banc One	-0.162
		Nordstrom	0.143
		K–Mart	-0.116
		Wilshire Small Cap	-0.132

Summary of the Regression Results – Dynamic Hedge with Changing Independent Variables

Table 5.3

Chapter 6: Hedging the RNI Sub–Indices

The supply of real estate is one of the primary factors affected by regional economic growth. The fortunes of real estate and labor, the two main factors of production, are closely tied to the performance of the local economy. There is ample evidence, both anecdotal and empirical, supporting the economic model of the regional nature of real estate.[3] A study published in 1987 concluded that property diversification on a regional basis is a factor which needs to be considered.[4] It was shown that regions perform differently; correlations for quarterly returns between regions were not strong. Geographical diversification, therefore, could be as important as diversification by property type in order to minimize risk in a real estate portfolio.

Since real estate returns are strongly influenced by both regional and property type effects, hedging at these levels was also examined. The Southeast RNI was used for analyzing the regional level and the West/Retail was used for examining hedging at the regional/ property type level. They were chosen partly due to the distance between the two, making it unlikely that they might exhibit any similarity.

6.1 Hedging the Southeast RNI

A selection of forty public companies was used in the hedging analysis. A complete listing of the companies is contained in Appendix B. Quarterly returns were obtained for the period from the 3rd quarter of 1988 to the 2nd quarter of 1994. The companies represent the largest publicly traded companies headquartered in the Southeast as well as several national firms. Although the selection basis is logical, it is somewhat simplistic since it ignores the flow of products and services between regions. A company headquartered in a region may have its manufacturing and distribution facilities in another region. Its economic impact may therefore be stronger outside the region in which it is based. The intent here, however, was to see if any relationship between the Southeast and the public markets existed which could be used as the basis for a hedging strategy. In terms of analysis, it represents a "first slice of the pie."

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[3] See DiPasaquale and Wheaton (1995).
[4] See Hartzell, Shulman and Wurtzebach (1987).

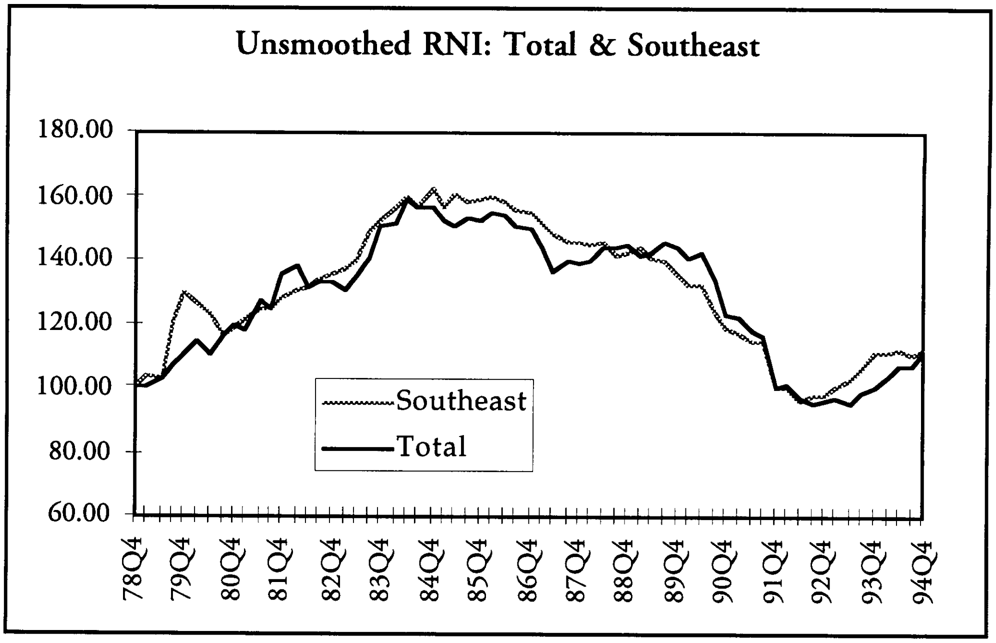

Figure 6.1

The unsmoothed total and Southeast RNI returns series are shown in Figure 6.1. Overall the two indices are very similar. They display considerable co–movement, peaking at approximately the same time as well as moving downward in similar periods. Except for the period before 1980, the Southeast displays less volatility than the total RNI.

For hedging the Southeast region, a similar method to that used on the total RNI and detailed in Section 5.3 was employed. This involved implementing a dynamic hedge with independent variables that were allowed to change every time that the hedge was rebalanced. The only difference in this case was that instead of rebalancing the hedge on an annual basis, as was done for the total RNI, the Southeast hedge was rebalanced quarterly. It was thought that the use of shorter periods would permit a more rapid capture of any changes in the relationship between the regional property market and the equity markets.

Stepwise regressions were performed on 16 quarters of data, rolling forward one quarter for each new regression. The results of the regressions are shown in Table 6.1. The significant independent variables for the each period examined are shown, as well as their

Period	88:3 – 92:2	***Period***	89:4 – 93:3
R2	0.75	R2	0.88
Citicorp	0.047	Starwood Lodging	0.047
Aetna	-0.177	Blockbuster Video	0.032
May Dept. Stores	0.199	Food Lion	-0.080
		Southern Company	-0.388
		T–Bonds	0.545
Period	88:4 – 92:3	***Period***	90:1 – 93:4
R2	0.80	R2	0.83
Food Lion	-0.135	Starwood Lodging	0.071
Blockbuster Video	0.029	Blockbuster Video	0.104
Delta Airlines	0.297	Carolina Power & Light	-0.237
Aetna	-0.072	Fieldcrest Cannon	0.073
Chubb	-0.056	First Union Bank	-0.094
Period	89:1 – 92:4	***Period***	90:2 – 94:1
R2	0.94	R2	0.84
Aetna	-0.227	Starwood Lodging	0.071
Winn–Dixie	0.181	Blockbuster Video	0.103
Citicorp	0.063	Carolina Power & Light	-0.226
Delta Airlines	0.199	Fieldcrest Cannon	0.072
Blockbuster Video	0.035	First Union Bank	-0.102
Period	89:2 – 93:1	***Period***	90:3 – 94:2
R2	0.96	R2	0.80
Starwood Lodging	0.023	Starwood Lodging	0.075
Food Lion	-0.071	Blockbuster Video	0.109
May Dept. Stores	0.233	Carolina Power & Light	-0.283
Aetna	0.097	Fieldcrest Cannon	0.098
Chubb	-0.039	First Union Bank	-0.067
Period	89:3 – 93:2		
R2	0.80		
Starwood Lodging	0.038		
Food Lion	-0.135		
Chubb	-0.085		
Duke Power	-0.055		
Delta Airlines	0.174		

Summary of the Regression Results – Southeast RNI Hedge

Table 6.1

regresssion coefficients and the resulting R^2s. Nine consecutive periods for hedging are included, beginning with the 3rd quarter of 1992 (using the results from the regression period 1988Q3 to 1992Q2) and ending with the 3rd quarter of 1994. The R^2s found are relatively high, ranging from 0.75 to 0.96. A certain degree of stability also appears to be present, as evidenced by the fact that the companies found to be significant show some consistency in consecutive periods.

The hedge ratios determined from the regressions were then tested in the subsequent out–of–sample period. A comparison of the unhedged and hedged positions using this strategy is shown in Figure 6.2.

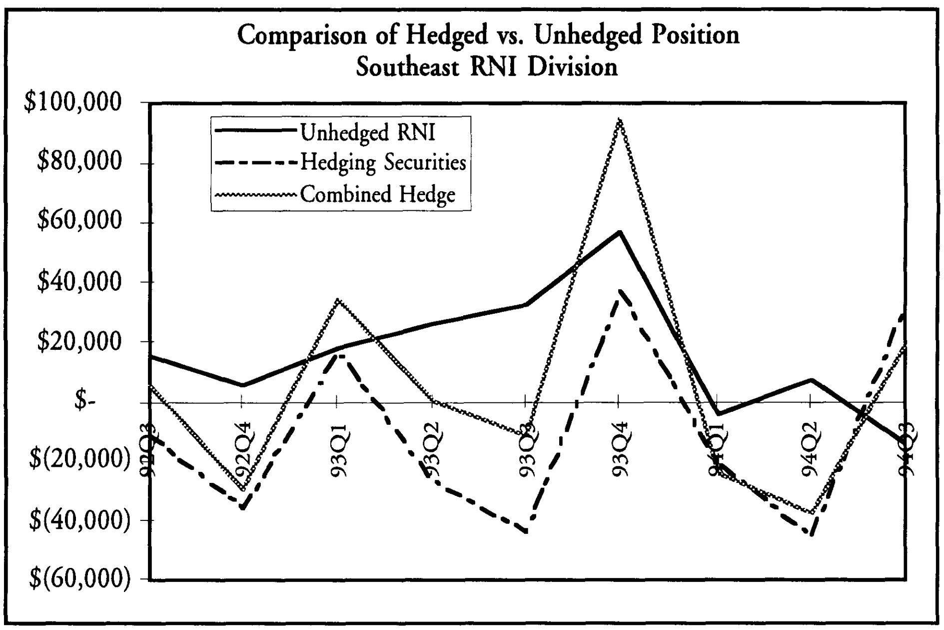

Figure 6.2

The plot for the unhedged position shows the quarterly gains and losses on a theoretical property worth $962,700 (the unsmoothed Southeast RNI level times $10,000) at the end of the 2nd quarter of 1992. The hedged portfolio assumes the same start value and apportions the hedging securities in accordance with the hedge ratios derived every quarter from regressions on the previous 16 quarters.

For example, for the hedge for the 3rd quarter of 1992, the following positions were assumed:

Short Position:	Hedge Ratio	Period Position in Dollars
Citicorp	0.047	$45,247 = (0.047 * $962,700)
May Dept. Stores	0.199	$191,577 = (0.199 * $962,700)
Long Position:		
Aetna	-0.177	$170,398 = (0.177 * $962,700)

Five variables were used in all periods except for the 93Q3 hedge. Only three significant variables were identified by the stepwise regressions for the 16 quarters preceding that particular quarter.

Ideally, the plot for the hedged portfolio should lie as close as possible to the X axis and have a value near zero at the end of every quarter. This is clearly not the case. The plot of the gains and losses for the hedged portfolio oscillates about the axis and displays more volatility than the unhedged RNI returns series. There is no discernable relationship between the two. The behavior of the hedged portfolio is markedly different from that witnessed with the hedge for the total RNI. In that case, the hedged and unhedged portfolios basically paralleled each other.

The quarter–by–quarter regression results, characterized by varying R^2s as well as independent variables (companies) which changed from period to period, is an indication of a lack of stability between the two markets. While reasonably high R^2s were found for the periods regressed, these relationships broke down outside the sample periods. This suggests that the regression results were primarily spurious and did not truly reflect the underlying fundamentals of the property and equity markets. A likely additional factor behind the poor hedged results is probably the lack of correlation between the two markets. As stated earlier, lack of correlation between financial instruments can potentially induce greater volatility when combined in a hedge portfolio.

6.2 Hedging the West/Retail RNI

For the West/Retail analysis, a total of 34 securities were used. These are listed in Appendix B. The majority of the firms selected were retailers, either national or western–based. In addition, some large western manufacturers were included. Equity indices, government treasuries as well as several large insurance companies and banks rounded out the selection. The period covered by the quarterly returns was identical to series used for the Southeast.

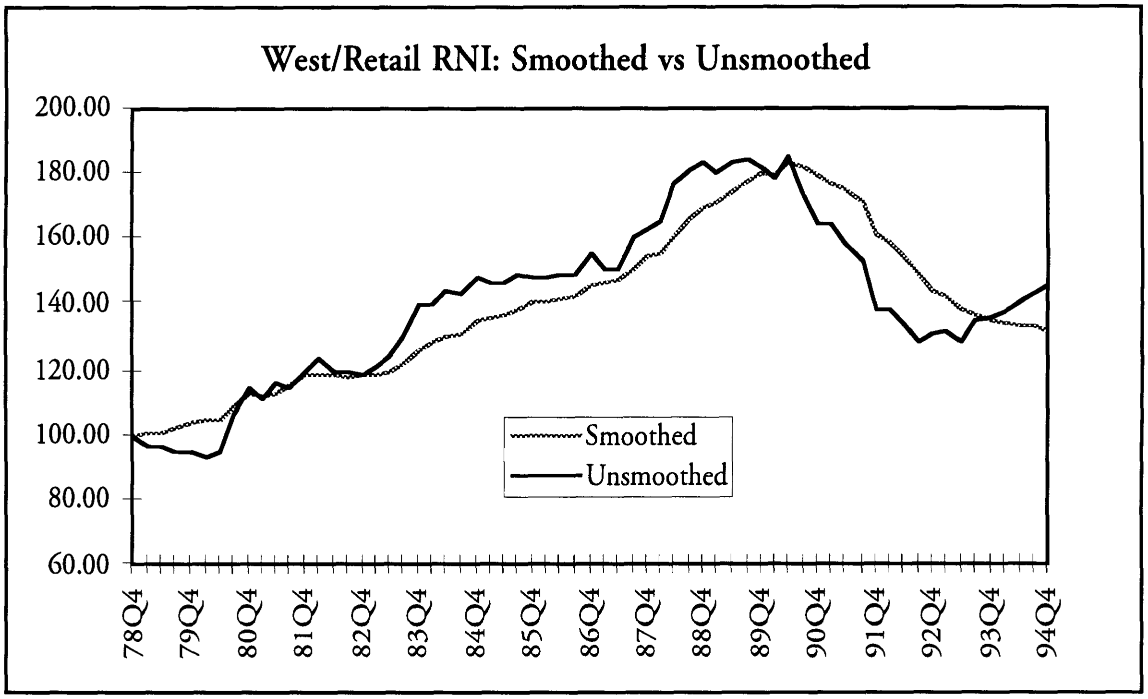

Figure 6.3

Figure 6.3 displays the smoothed and unsmoothed indices for the West/Retail section of the RNI. The plots shows that the smoothed index lags the unsmoothed by approximately one year. The unsmoothed index is clearly more volatile than its smoothed counterpart.

An identical method of analysis was used as performed on the Southeast returns series. The results of the stepwise regressions are shown in Table 6.2. The R^2s found range from 0.62 to 0.89. Some stability also appears to be present in these results, with the same companies selected as the significant variables in several consecutive quarters.

Period	88:3 – 92:2	***Period***	89:4 – 93:3
R2	0.86	R2	0.80
May Dept. Stores	0.434	May Dept. Stores	0.315
Security Capital Pacific	-0.087	The Limited	-0.111
Nike	0.013	Nike	-0.068
McKesson	-0.201		
K–Mart	-0.187		
Period	88:4 – 92:3	***Period***	90:1 – 93:4
R2	0.80	R2	0.84
Albertson's	0.113	May Dept. Stores	0.243
The Limited	-0.097	The Limited	-0.120
Gap	0.052	Nike	-0.092
Security Capital Pacific	-0.121	T-Bond	-0.099
Dole	0.096	Nordstrom's	0.062
Period	89:1 – 92:4	***Period***	90:2 – 94:1
R2	0.86	R2	0.68
May Dept. Stores	0.197	May Dept. Stores	0.297
Security Capital Pacific	-0.169	The Limited	-0.111
K–Mart	-0.113	Nike	-0.07
Nordstrom's	0.061		
Nike	0.045		
Period	89:2 – 93:1	***Period***	90:3 – 94:2
R2	0.89	R2	0.62
May Dept. Stores	0.310	Nordstrom's	0.104
The Limited	-0.055	Microsoft	-0.116
K–Mart	-0.117	The Limited	-0.059
Security Capital Pacific	-0.054	May Dept. Stores	0.110
Long's Drugs	0.076		
Period	89:3 – 93:2		
R2	0.86		
May Dept. Stores	0.318		
The Limited	-0.102		
Security Capital Pacific	-0.077		
Nike	-0.045		

Summary of the Regression Results – West/Retail RNI Hedge

Table 6.2

Figure 6.4 shows the comparison between the hedged and unhedged positions for the subsequent out–of–sample hedge. The assumed property value at the start of the hedge was $1,339,600, representing the level of the index times $10,000. The behavior displayed by the hedged position is completely different from that seen with the Southeast hedge. The hedged and unhedged position show considerable co–movement in this case. In fact, in only two of the nine quarters do the two positions move in opposite direction. These results are similar to those found for hedging the total RNI.

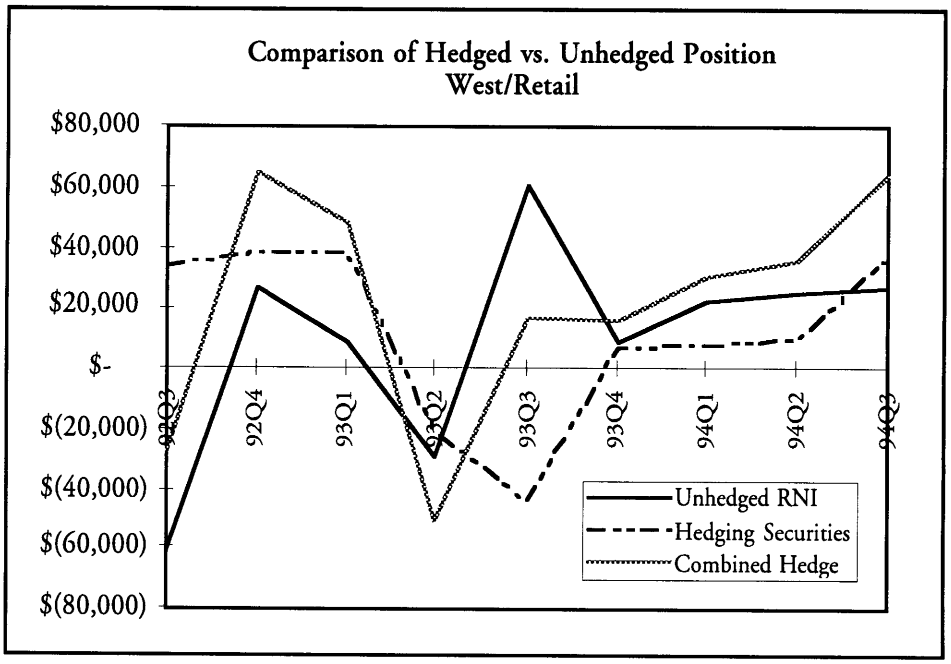

Figure 6.4

6.3 Conclusions

In both the case of the unsmoothed Southeast and West/Retail returns series, independent variables which are statistically significant and which have relatively high R^2s have been found using stepwise regressions. The companies comprising the set from which the independent variables were drawn have a logical relationship with the regressor: regional in the case of the Southeast and both regional and property type in the case of the West/Retail.

Although the results from the stepwise regressions were encouraging, the derived hedges did not perform well in out–of–sample testing. In neither case was there any evidence of any hedging actually being provided by the hedged portfolio. The hedged portfolios, in fact, were at least if not more volatile than the unhedged portfolios.

The two differ greatly, however, in the behavior of the hedged portfolio. The Southeast hedge indicates the possibility of the presence of a mean reverting process. The West/Retail hedge, on the other hand, tends to move with the unsmoothed RNI.

One of the problems with this analysis is the low number of observations which results from returns reported quarterly. This, of course, is a related to the problems of price discovery and liquidity which were discussed in the earlier chapters. It might be possible to improve on the results obtained in this study if data of greater frequency was available. Given the lack of correlation between the equities and the returns indices, however, it is unlikely that hedging in this manner would prove very successful.

Chapter 7: Summary and Conclusions

The ability to hedge volatility is an important tool for the investor. It allows him to reduce the risk to which he is exposed and to be somewhat more certain of the returns he can expect to receive in the future. Hedging volatility in many asset classes is made possible by the presence of a wide array of financial instruments available in the marketplace. However real estate, despite its enormous size and importance, has to date been largely ignored in this regard. The aim of this study was, therefore, to address this issue by examining the feasibility of hedging commercial property returns with traded securities.

The Russell–NCREIF Index was used as a proxy for commercial property returns. The RNI is probably the most widely recognized commercial real estate index in the United States. Since only a very small percentage (approximately 5 percent) of the properties in the index turn over in a given year, actual sales data is limited. Values for the majority of the stock represented in the index must be determined by appraisals. The index, being an appraisal–based returns series, does not necessarily represent true returns. The "tyranny of past appraisals," as well as other aspects inherent in the construction of the RNI, tends to smooth and lag the index. This smoothing results in the true volatility being understated. By assuming a consistent model of appraisal behavior, however, it is possible to extract a true returns series (unsmoothed and de–lagged) from the observed, appraisal–based series.

In this study, three components of the RNI were examined: the total RNI (the national returns), the Southeast Index and the West/Retail Index. This permitted analysis at the national, regional and property type level. It is generally agreed that diversification at these levels can have significant effects on real estate portfolio performance. A different selection of securities was used for each of the components. At the national level, the securities chosen had hypothetical ties with the real estate industry (for instance large banks, insurance companies and REITs). For the Southeast hedge, the largest publicly traded companies in the region were used. In the case of the West/Retail hedge, the majority of the securities used were retailers, although several of the large regional employers were also included.

Once the indices were unsmoothed, the OLS approach was used to establish the hedge ratios. The securities utilized in the hedges were obtained by running stepwise regressions with the true returns series as the dependent variable and the securities as the independent variables. The significant variables were identified in this fashion. In order to avoid the problems associated with using too many parameters, the number of securities used to hedge in a given period was limited to a maximum of five.

A rolling four year window was used in the regressions. The intent behind using this length of time was so that only the most recent and relevant information was included in the analysis. Given that returns data is only available on a quarterly basis, four years is also a practical figure. Any period having a shorter duration suffers from an insufficient number of observations. The resulting hedge ratios were then applied and tested in subsequent out–of–sample periods.

In spite of the high R^2s found in the regressions, the hedge portfolios displayed little hedging capabilities out–of–sample. Rather than reduce volatility, moving from an unhedged to a hedged position actually increased volatility in many of the periods examined. Returns from the hedged portfolios generally displayed large co–movement with the unhedged portfolio. It is obvious that the apparent stability in the sample periods used in the regressions did not hold up out–of–sample. The low correlation between the securities and the property returns is the likely cause for the ineffectiveness of the hedge.

Given the size of the asset class, hedging volatility will continue to be a matter of interest. Hedging with traded equities, however, does not appear to be a successful strategy for hedging commercial property returns. In spite of increasing securitization, the real estate industry continues to be "unique" in many ways. Given this uniqueness, until such time as index–based real estate derivatives are available, it is unlikely that hedging with other instruments will prove successful.

Appendix A: Unsmoothing the RNI Sub–Indices

Region	Lagged Quarters	Unsmoothing Equation
East	2 & 4	$1.9833(r^*_t - 0.3561r^*_{t-2} - 0.2690r^*_{t-4})$ (3.20) (2.43)
Midwest	3 & 4	$2.8574(r^*_t - 0.1696r^*_{t-3} - 0.5578r^*_{t-4})$ (1.60) (5.26)
South	1 & 3	$2.2020(r^*_t - 0.2827r^*_{t-1} - 0.2699r^*_{t-4})$ (2.40) (2.30)
West	4	$2.5798(r^*_t - 0.7206r^*_{t-4})$ (8.70)

Table A.1
Significant Lags and Unsmoothing Equations
for the
RNI Regional Indices

Correlation Matrix	Total	East	Midwest	South	West
Total	1.00	0.64	0.69	0.66	0.80
East	0.64	1.00	0.39	0.37	0.39
Midwest	0.69	0.39	1.00	0.43	0.55
South	0.66	0.37	0.43	1.00	0.38
West	0.80	0.39	0.55	0.38	1.00

Table A.2
Cross–Correlation Coefficients
for the
RNI Regional Indices

Region	Lagged Quarters	Unsmoothing Equation
East North Central	4	$2.5512(r^*_t - 0.6169r^*_{t-4})$ (6.18)
Mideast	1 & 4	$2.0883(r^*_t - 0.2515r^*_{t-1} - 0.3764r^*_{t-4})$ (2.23) (3.38)
Mountain	1 & 4	$1.8877(r^*_t - 0.2692r^*_{t-1} - 0.3682r^*_{t-4})$ (2.41) (3.28)
Northeast	3 & 4	$1.3119(r^*_t - 0.2557r^*_{t-3} - 0.1778r^*_{t-4})$ (2.47) (1.72)
Pacific	4	$2.5930(r^*_t - 0.7801r^*_{t-4})$ (10.26)
Southeast	3 & 4	$2.2360(r^*_t - 0.2341r^*_{t-3} - 0.3642r^*_{t-4})$ (1.97) (3.09)
Southwest	1	$1.8351(r^*_t - 0.2831r^*_{t-1})$ (2.40)
West North Central	1 & 3	$2.9990(r^*_t - 0.4091r^*_{t-1} - 0.3233r^*_{t-4})$ (3.59) (2.82)

Table A.3
Significant Lags and Unsmoothing Equations
for the
RNI Divisional Indices

Property Type	Lagged Quarters	Unsmoothing Equation
Apartment	1 & 4	$2.1915(r^*_t - 0.2674r^*_{t-1} - 0.6169r^*_{t-4})$ (2.31) (3.11)
Office	2, 3 & 4	$2.0707(r^*_t - 0.1695r^*_{t-2} - 0.1562r^*_{t-3} - 0.4787r^*_{t-4})$ (2.23) (3.38) (5.16)
R&D Office	1 & 4	$2.1765(r^*_t - 0.4388r^*_{t-1} - 0.3186r^*_{t-4})$ (3.99) (2.90)
Retail	1 & 4	$3.0855(r^*_t - 0.1878r^*_{t-1} - 0.5959r^*_{t-4})$ (1.85) (5.90)
Warehouse	3 & 4	$3.1836(r^*_t - 0.2119r^*_{t-3} - 0.5363r^*_{t-4})$ (2.04) (5.16)

Table A.4
Significant Lags and Unsmoothing Equations
for the
RNI Property Indices

	Apartment	Office	R&D Office	Retail	Warehouse
East	0.24	0.73	0.35	0.41	0.41
Midwest	0.49	0.56	0.41	0.60	0.64
South	0.64	0.43	0.39	0.40	0.46
West	0.40	0.67	0.59	0.57	0.74

Table A.5
Cross–Correlation Coefficients
for the
RNI Regional & Property Indices

West/Property Type	Lagged Quarters	Unsmoothing Equation
Office	4	$1.5959(r^*_t - 0.7582r^*_{t-4})$ (9.38)
R&D Office	1 & 4	$1.2526(r^*_t - 0.3614r^*_{t-1} - 0.2367r^*_{t-4})$ (3.08) (2.01)
Retail	1 & 4	$2.4928(r^*_t - 0.2085r^*_{t-1} - 0.5348r^*_{t-4})$ (2.03) (5.23)
Warehouse	1, 3 & 8	$2.4511(r^*_t - 0.2269r^*_{t-1} - 0.230r^*_{t-3} - 0.3878r^*_{t-8})$ (2.41) (2.47) (3.77)

Table A.6
Significant Lags and Unsmoothing Equations
for the
RNI West/Property Indices

Appendix B

B.1 Equities used in the Stepwise Regressions for the Southeast RNI Hedge

1. Turner Construction
2. W.R. Grace
3. Blockbuster Video
4. Georgia–Pacific
5. Delta Airlines
6. Bruno's
7. Springs
8. NuCor
9. Fieldcrest Cannon
10. Vulcan Metals
11. FPL Group
12. Southern Company
13. Carolina Power & Light
14. Duke Power
15. Aetna
16. Cigna
17. Travelers Insurance Company
18. Chubb
19. American International Group
20. NationsBank
21. Chase Manhattan Bank
22. Citicorp
23. Chemical Bank
24. First Union Bank
25. Barnett Banks
26. S&P 500 Index
27. Russell 2000 Index
28. Wilshire Small Cap Index
29. May Department Stores
30. Winn–Dixie
31. Home Depot
32. Low
33. Wal–Mart
34. Food Lion
35. Treasury Notes
36. Treasury Bonds
37. Federal Realty Investment Trust
38. MGI Properties
39. Starwood Lodging
40. United Dominion Realty Trust

B.2 Equities used in the Stepwise Regressions for the West/Retail Hedge

1. S&P 500 Index
2. Russell 2000 Index
3. Wilshire Small Cap Index
4. Treasury Notes
5. Treasury Bonds
6. K–Mart
7. May Department Stores
8. Nordstrom's
9. Bank of America
10. BRE Properties
11. MGI Properties
12. Security Capital Pacific
13. Boeing
14. Weyerhauser
15. Nike
16. Louisiana–Pacific
17. Long's Drugs
18. The Gap
19. The Limited
20. Disney
21. Lockheed
22. Northrop
23. Litton Industries
24. Dillard Department Stores
25. Albertson's
26. Mattel
27. McKesson
28. Apple Computer
29. Intel
30. Sun Microsystems
31. Hewlett Packard
32. Dole
33. Circle K
34. Microsoft

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