Liquefying Risk in the U.K. Commercial Real Estate Market

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ABSTRACT

This thesis considers two issues. The first is whether it is possible to replicate commercial real estate returns by developing a proxy of publicly traded securities. The second is the possibility of using publicly traded securities to predict commercial real estate returns, thereby creating a viable financial instrument in which real estate risk could be hedged. The thesis focuses on the United Kingdom's real estate market and utilizes the capital appreciation portion of the IPD Monthly Index, which is unsmoothed to uncover the "real" returns generated by real estate. The fundamental hypothesis is that there is a link between the stock prices of large users of real estate and the returns being generated by the real estate they occupy. Our findings suggest that up to 92% of the real estate returns can be replicated using only 15 publicly traded securities. This strongly suggests that the returns generated by real estate may not be as idiosyncratic as previously thought and that real estate may not bring any significant diversification benefits to investment portfolios that are not already available in the public security markets.

Applying these findings to the development of a predictive hedge produced less conclusive results. Although we were able to develop a methodology that achieved good results over a six month period, the predictive powers of the hedge on a month to month basis were not strong. Nonetheless, we believe that our results are encouraging and provide direction for further research, as a more extensive database becomes available.

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Liquefying Risk in the U.K. Real Estate Market

Chapter 1: Introduction

This thesis will consider the use of publicly traded equities in both replicating and predicting the returns to direct commercial real estate investment. One of the most challenging problems concerning real estate investors today is the inherent illiquidity of the asset and the lack of alternatives that could allow investors the ability to hedge their exposure to real estate. The creation of such a "return proxy" would allow investors, as well as direct owners of real estate, an important financial vehicle through which they would be able to isolate and "liquefy" the risk of their real estate exposure. By utilizing only existing publicly traded equities, the proxy would have the same liquidity as is currently available to investors in the stock and bond markets. In addition, investors may be able to utilize the proxy to obtain the diversification benefits of direct ownership of real estate without the inherent problems that accompany ownership, such transactions costs and management fees. In fact,

> "Direct ownership of real estate may be avoided entirely if a replicating portfolio of liquid or quasi-liquid securities can be found that matches returns to real estate."[1]

1.1 Diversification Benefits

The benefits of including real estate in a diversified portfolio have been long studied. Real estate returns' apparent low correlation with stocks and bonds (0.2 and 0.0, respectively[2]) enable investors to lower the overall volatility in their portfolio for a given return. This is the basis for rational quantitative investment analysis known as Modern Portfolio Theory (MPT), which was developed by Markowitz, Sharpe and others in the 1950's and 1960's.

> "MPT has provided much of the underlying motivation for including real estate in the pension fund portfolio, because real estate has been seen as a potential diversifier of stocks and bonds, which dominate most pension funds' portfolios."[3]

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[1] Riddiough, 1995.
[2] Hartzell, Wurtzebach and Watkins, 1995.
[3] Geltner, Rodriguez and O'Conner, 1995.

However, when property values fell during the late 1980's and early 1990's, many investors found that the asset's illiquidity and high transaction costs made it difficult to reallocate their portfolios to adjust to real estate's changing risk/return profile, and therefore prohibited the investors from being able to properly manage their risks.

Numerous studies have also indicated the benefits of diversification within the real estate asset class itself.

> "Regional diversification of real estate portfolios has been shown to provide benefits to investment managers by reducing the unsystematic risk associated with the fluctuation of portfolio returns. The two most important elements of portfolio construction include the creation of homogeneous categories, in this case geographic areas (as opposed to product types), and the coefficient of correlation between categories."[4]

Both investors and direct property owners could lower their exposure to unsystematic real estate risk by holding properties in different regions of the country.

> "However, the obstacles to investing in large, diversified baskets of commercial real estate are prohibitive to most investors. Transaction costs are substantial, and diversification across geographical location and property type through the physical market would require unrealistically large sums."[5]

Direct owners of real estate face an additional problem whereby "the illiquidity in commercial real estate manifests itself as a near-total lack of hedge markets."[6] Due to the high costs of acquiring and owning real estate, current owners of the asset may be unable to diversify their holdings either by property type or geographically. This problem typically leaves property owners unable to reduce their real estate exposure through diversification. That is, property owners are locked into a "long" position, in terms of the property's rental income and capital appreciation, due to the lack of a mechanism that would allow them to reduce their market risk by obtaining a "short" position in their idiosyncratic exposure to real estate.

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[4] Malizia and Simons, 1991.
[5] Kerson, 1994.
[6] Ibid.

1.2 Risk Management

No widely accepted mechanism currently exists that allows investors to diversify their investments in real estate without incurring significant costs. Nor do individuals or institutions with large exposures to specific real estate risks currently have any way of hedging those risks.

> "In order to hedge their portfolio, these owners of real estate should go short in index-based real estate derivatives that are closely correlated with the real estate that they live in or operate."[7]

For various reasons, firms usually prefer to own real estate that they use in connection with their operations. But they have no mechanism through which they are able to hedge the risk of these holdings.[8]

Prior attempts have been made to address the problem of hedging real estate risk, including: trading property futures contracts on The London Futures and Options Exchange (London FOX); the Chicago Board Options Exchange REIT Index; a back-to-back swap deal between Morgan Stanley and Aldrich, Eastman and Waltch, a Boston based fund manager; and the development by Bankers Trust of a derivative index comprised of public REITs, REOCs and small cap stocks. These attempts will be discussed in some detail in Chapter 2. However, it is important to note that none of these efforts have, thus far, been widely accepted or utilized in the marketplace, due to transaction costs, timing issues and thin volume.

1.3 Research Methodology

To address these problems, an alternative methodology that utilizes only publicly traded equities to replicate and predict the true returns of real estate will be analyzed. Mechanically, this approach should have the following advantages. First, the methodology does not require the formation of any additional financial instruments, such as a derivative index or real estate futures exchange. Second, since the methodology utilizes only currently existing publicly traded equities, liquidity should not be a major issue. Third, unlike a back-to-back swap, specific counterparties do not have to be found for each transaction. Finally, unlike a derivative index which may attempt to isolate real estate risk from systematic stock market risk by relying primarily on REITs and

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[7] Kerson, 1994.

[8] Case, Shiller and Weiss, 1993.

REOCs to replicate real estate returns, this approach will not have to account for other factors that differentiate those returns from true real estate returns, i.e., management, growth potential, etc.

Our approach is straight forward. We hypothesize that there exists a strong relationship between property values and the financial well being of the property's end user. This financial well being is directly reflected in the stock prices of the end users and may be an indication of their requirements for property, as well as their ability to pay for that use going forward, i.e., expansion, upgrades and generally higher leases during good times, and the opposite during periods of contraction.

> "At the least sophisticated level of economic theory lies the belief that certain pairs of economic variables should not diverge from each other by too great an extent, at least in the long run."[9]

Therefore, in the specific case of property values, which are essentially determined by discounting future net operating income (NOI), there should exist a strong correlation with the present value of future profits of the end users, which is directly reflected by the company's current stock price. In a general sense, if a company is projected to do well and to grow, its stock price will increase. Likewise the company's demand for real estate and its ability to pay for real estate will also increase. Therefore, one would expect the level of a company's success to be reflected in the value of the real estate that it requires.

This approach builds upon previous research by others attempting to find fundamental relationships between returns of privately held real estate and publicly traded real estate related equities, such as REITs, REOCs, construction companies, etc. For instance, previous attempts by Henry and Ward (1995) to develop a replicating proxy for the U.K.'s JLW real estate index utilized stocks, indices, and government bonds "that might be expected to be influenced by the state of the property market."[10] However, instead of focusing on companies whose success is influenced *by* the property market, our approach will focus on companies that we believe should exert influence *on* the property market.

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[9] Granger, 1986.
[10] Henry and Ward, 1995.

In short, the value of a real estate asset may be directly influenced by the value of its tenants. If a strong correlation between property valuation and the valuation of the end users can be established, a proxy for real estate returns could then be established, utilizing only the publicly traded equities of the companies that represent the users of real estate. Furthermore, this relationship should also exist on a disaggregated, industry sector basis. By its very nature, such a proxy would have the liquidity of the public equity markets, including the ability hedge risk by short selling.

In order to test this hypothesis, we established a two stage process. First, we sought to establish that it was possible to develop a replicating proxy for real estate returns utilizing only publicly traded equities. This methodology is described in Chapter 3. Second, based upon the success of the first stage, we sought to establish a methodology for utilizing the correlation between real estate returns and returns on public equities to develop a predictive hedge instrument for future real estate returns. This methodology is described in Chapter 4.

1.4 The United Kingdom Property Market

The U.K. market was chosen for this research because of its geographically concentrated property market, the availability of monthly real estate return data and relative homogeneity of the property types. Seventy-five percent of the U.K.'s commercial real estate is located within the London MSA; consequently, it is appropriate to view the U.K. market as being relatively geographically homogeneous.[11] This selection simplified the analysis and provided the opportunity to apply the methodology to the entire U.K. property market as a whole, disaggregating only by property type.

The Investment Property Databank (IPD) produces several appraisal based real estate indices in the U.K. We elected to use the IPD index because it contains detailed monthly return data and is disaggregated into three industry sectors. See Chapter 3.2 for additional discussion. The denser, more homogeneous U.K. market exhibits less appraisal smoothing than the U.S. market[12] and the monthly reappraisal of all properties in the IPD Index results in less temporal aggregation than the U.S. indices with their staggered annual reappraisals. The IPD Monthly Index provides a short term measure of commercial property market movements based on the performance of the

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[11] Hoesli, MacGregor and Lizieri, 1996.
[12] Barkham and Geltner, 1995.

properties held by 53 funds, consisting of property Unit Trusts, Unit Linked Insurance Funds and Managed Pension Funds, which are valued monthly. The IPD Monthly Index includes over 2250 properties, which are split into three sectors; industrial, office and retail.

In addition, due to the fact that the "U.K. property markets also appear to be more positively correlated on a contemporary basis, with a broad-based index of the country's stock market, particularly in the case of the unsecuritized property markets,"[13] we believe that there could well exist a similar relationship between sectorally disaggregated real estate returns and same sector industry returns. For larger, more diverse markets, such as the United States, the basic approach would be the same. However, special attention would need to be given to the effects of geographic diversity and local economic conditions.

Chapter 2: Literature Review and Background

2.1 Appraisal Based Real Estate Return Indices

The real estate industry suffers from a lack of reliable publicly available data on investment performance. This has made it very difficult to measure the true returns generated on an ongoing basis.

> "The lack of reliable real estate returns data has hampered real estate research and performance measurement. Real estate is traded infrequently, is not homogenous, and lacks a central marketplace where prices are made public."[14]

Due to this lack of data, practitioners and academics alike have relied heavily on appraisal based indices to analyze the returns from privately held commercial real estate. Researchers [Giliberto 1988 and Geltner 1989a, b] have realized that appraisal based indices have inherent problems which, if not corrected, can lead to an inaccurate portrayal of the returns generated by real estate. This section identifies some of these issues and discusses the methods researchers have formulated to address them. Specifically the following will be discussed in turn:

1. Bias in appraisal-based returns
2. Appraisal smoothing and temporal aggregation

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[13] Barkham and Geltner, 1995.
[14] Eichholtz and Hartzell, pg. 163.

Bias in appraisal-based returns:

Fundamentally, appraisal bias results from fact that actual transactions in real estate are relatively infrequent. Because of this, real estate property indices are not transaction based but rather must rely on appraisals to update property valuations. Since appraisers do not have empirical, current data, they must rely on past valuations of the subject property and past sales prices of comparable properties. This results in a backward looking bias in the appraiser's valuations. That is, current valuations contain components of the past valuations. Giliberto [1988] recognized that, with respect to capital appreciation, appraisal based indices biased the holding period return series for a portfolio of real estate. The definition of the holding period return (r_t) is the difference in value (V) between two points in time.

$$r_t=V_t/V_{t-1}-1$$

Unless the portfolio is actually traded at times t and t-1 then the actual, or true, returns are unobservable. In practice, this equation becomes:

$$r^*_t=V^*_t/V^*_{t-1}-1$$

where r^*_t is the observed appraisal based return and V^*_t is the appraised value of the portfolio at time t. Realizing that:

$$V_t=V^*_t+\varepsilon_t$$

here ε_t is an estimate of the appraisal error and V_t is deterministic, ex post, but also unobservable, Giliberto modeled the bias in r^*_t as an estimate of r_t, and concluded that appraisal return bias may exist in the return even though the appraised values in levels are unbiased. He further shows that the bias will always be positive if the appraisal errors are serially uncorrelated.[15]

However, Geltner [1989a] notes that,

> "The holding period return is useful for measuring the ex post performance of a portfolio between two points in time. Our analysis suggests that this type of bias is minor if appraised values in levels are unbiased and the portfolio value has changed by a large fraction during the holding period (as would often be the case over a long holding period). Moreover, under some assumptions that may often be plausible, this bias problem can be avoided by the use of continuously compounded rate of return over the holding period."[16]

In doing so, Geltner assumes that the standard error of the appraised value is a constant fraction of the true value and that the error terms follow a pattern of a normal distribution. It is important to

[15] Geltner, 1989a, pg. 340.
[16] Geltner, 1989a, pg. 350.

note that both Giliberto's and Geltner's work centered on the US based Frank Russell Company (later renamed NCREIF) and PRISA indices.

Appraisal smoothing:

Smoothing has been defined as a "bias towards zero in return time-series second moments."[17] Smoothing may enter an appraisal based index at either the aggregate or disaggregate level. There are two basic causes of smoothing[18]:

1. Lack of confidence.
2. Valuation timing.

Lack of confidence: Since the property is not actually sold, the appraiser can not be 100% certain that the appraisal represents, in fact, the true market value of the property in question. This leads to a lack of confidence in the appraisal. Defining the appraiser's confidence factor as α , where $0 \leq \alpha \leq 1$, then:

$$V^*_t = \alpha V_t + (1-\alpha) V^*_{t-1} \qquad (1)$$

where V_t is the true property value and V^*_{t-1} is the appraisal one period ago. The above "results in the appraised value at time t being a moving average of current and past true property values."[19] Taking the first differences and approximating the returns as the differences in value ($r_t \approx V_t - V_{t-1}$), implies that "the appraisal-based return is an exponentially weighted moving average of true returns."[20] This leads to the conclusion that most of the risk in the return series is due to capital appreciation. Further, if one uses continuously compounded returns rather than holding period returns, then the above approximation is an exact relationship.

Expanding upon (1) above to reflect a true series, Geltner [1991] shows that:

$$r_t^{i*} = \eta_t^i + w_0^i r_t^i + w_1^i r_{t-1}^i + \ldots \qquad (2)$$

where η represents the random error term of the appraisal and w is a weighting factor. If the error is truly random then it will approach zero for a large set of observations, such as in an index. Accordingly, the value of Equation (2) represents the disaggregate (property) level return while $r_t^{i*} - \eta_t^i$ represents the index (portfolio) level of returns.

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[17] Geltner 1993, pg. 141.
[18] Geltner 1989b, pg. 469.
[19] Ibid. pg. 470
[20] Ibid.

Valuation timing: Within a portfolio of properties some will have been more recently appraised than others. This leads to an issue of temporal aggregation, which is defined "as 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."[21] The primary reason for issues with temporal aggregation is due to the lack of a significant volume of contemporaneous transactions. Geltner [1993] provides a rigorous study of the affects of temporal aggregation, the mathematics of which will not be repeated here. The conclusions, however, can be summarized as follows:

1. Temporal aggregation affects appraisal based, transaction based and hedonic real estate indices due to the thinness of the commercial real estate market.
2. Not correcting for the affects of temporal aggregation will cause an over allocation to real estate when applying modern portfolio theory diversification techniques to commercial real estate, stocks and bond return series.
3. Temporal aggregation can be almost completely avoided by simply reducing the frequency of the return series observations to a half or a quarter of the underlying index. This may, however, lead to other problems by reducing the amount of disaggregate data.

The net affect of temporal aggregation is that the appraised values will be a moving average of the underlying true values. The moving average of a stochastic process is a smoothed version of the underlying stochastic process itself, but displays less variation than the underlying process.[22]

In conclusion, appraisal based indices have problems which are widely known and have been the subject of much study. "No index is perfect"[23] however, and "one can use an index effectively only when one understands how it was created."[24] With the amount of study that has gone into appraisal based indices, they can in fact provide a vast amount of information, once corrected for recognized faults.

2.2 Geographic and Sectoral Diversification

The ability to diversify "within" real estate has been widely studied since the early 1980s. The objective is that once an investor had made the decision to diversify into real estate, perhaps the efficient frontier, as defined by modern portfolio theory, could be further moved by investing in properties with a low covariance between their respective returns.

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[21] Geltner 1993, pg. 141.
[22] Geltner 1989b, pg. 471.
[23] DeVries, Miles, Wolgin 1992, pg. 7.
[24] Ibid.

In the U.S., geographical delineation, for the purposes of diversification, is typically defined as the individual states. The NCREIF combines the states into four very broad geographical regions (East, West, Midwest and South). A study by Hartzell, Hekman and Miles concluded that the four geographic categories were too broad, and called for a more exacting differentiation based upon more localized geographical classification and a variety of property specific considerations.[25] In 1987, the regional categories were broaden by Hartzell, Shulman and Wurtzebach to a total of eight categories. Their innovation was not to divide the country along predetermined state boundaries, but by "cohesive economic activity regions."[26] Their results indicate that the eight region model provides superior diversification benefits vis-à-vis the four region model.

Mueller further refined the by dividing the country into nine "Economic Base Categories."[27] These categories are based upon the dominant economic base for each of the 316 metropolitan statistical areas (MSAs) in the U.S. A dominant economic base was defined as the largest sectoral employer in the MSA as categorized by standard industrial classification (SIC) group. The economic similarity of the groupings lead to a remarkable geographic diversity as, for example, Charleston SC, New London CT and San Antonio TX were all in the same group.[28] The study concluded that local economics plays a more important role in diversification than purely geographic groupings. Interestingly, the proposed model does not perform well during the cycle from 1983 through 1990, which of course includes the recent downturn in the real estate market. Mueller postulates that this because much of the construction during this time frame was not driven by economics, but by investment and tax considerations.[29]

The technique of dividing up a large geographic region by similar economic drivers using total employment as a proxy was applied to Europe by Hartzell, Eichholtz and Selender. With regard to the U.K., their work showed that the greater London area is dominated by the finance, insurance and real estate (FIRE) service sector, the West Midlands region surrounding Birmingham by the metal manufacturing (e.g. automobile industry) and area around Newcastle upon Tyne to the North by energy. The remainder of the U.K. is considered diversified, or not dominated by any

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[25] Hartzell, Hekman and Miles 1986, pg. 252.
[26] Hartzell, Shulman, Wurtzebach 1987, pg. 86.
[27] Mueller, 1993, pg. 56.
[28] Ibid. pg. 60.
[29] Ibid. pg. 62.

particular industry.[30] Although the authors are technically correct in stating that "there are no return data for a general European real estate portfolio"[31] there are several indices available in the U.K. Also, while certainly not available for use by the authors at the time of publishing, an index has also been started in the Netherlands as of July 1996. One of the recommendations of the study was to further develop the link between real estate returns and employment characteristics.[32]

Using one of the aforementioned indices (Hillier Parker), Hoesli, Lizeri and MacGregor study diversification within the U.K. market (with the exception of Northern Ireland due to a lack of data). The authors use several clustering techniques to attempt to discern whether real estate returns are grouped by geographic region or by sector. Their methodology acknowledged the differing economic drivers as defined by the employment segregation technique by Hartzell et al. Their results found that property type was the most important consideration for diversification within the real estate markets in the U.K.[33] The sectors identified were retail, London office, and industrial with the non-London offices closely following the industrial sector. As for geography, there appears to be some evidence that it does play a role on a very broad basis. That is, the country is roughly divided into three categories: London, the area surrounding London, and everywhere else. The London region is dominant. These results have led us to concentrate on the sectoral disaggregation, and for the purposes of our thesis, to view to U.K. property market as being geographically homogeneous.[34]

2.3 Linking Returns of Public and Private Real Estate

Traditionally, investors desiring exposure to the equity real estate markets simply purchased property on a debt free basis or allowed their equity to be leveraged with debt. The property produced income on an ongoing basis with capital appreciation realized at the time of sale or refinancing. However, in the United States a change in the tax laws in the early 1960s allowed for the formation of real estate investment trusts (REITs) which were traded daily on stock exchanges. Provided they followed certain structural rules, REITs were able to deduct dividend payments to the holders of their stock before paying taxes. For a variety of reasons (which will not be discussed in this paper), REITs grew to only about $7 billion by the end of the 1980s, but then

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[30] Hartzell, Eichholtz and Selender 1993, pg. 21.
[31] Hartzell, Eichholtz and Selender 1993.
[32] Ibid. pg. 17.
[33] Hoesli, Lizeri and MacGregor 1996
[34] Hoesli, Lizeri and MacGregor 1996

rapidly expanded to about $70 billion by the end of 1995. While many questions still surround REITs as to whether or not they truly "are real estate", most practitioners and academics believe that the industry has reached a critical mass and is here to stay.

Several authors [Giliberto 1990, Ross and Zisler 1991, Gyourko and Kiem 1992, et al.] have explored the relationship between the returns generated by the private and public markets. As was discussed in chapter 2.1 one of the first obstacles encountered was the difficulty in measuring the returns generated by privately held real estate. In the U.S., a widely followed index of private real estate returns was started by the Frank Russell Company and is currently published by the National Council of Real Estate Investment Fiduciaries (NCREIF). The data series starts in 1977 and is compiled and published quarterly. As of the first quarter of 1996, the NCREIF index tracks over 1900 properties with an unlevered value of approximately $30 billion. The assets are owned primarily by pension funds.

While acknowledging that the NCREIF index is less than perfect, researchers have linked public and private returns with varying degrees of success. Gyourko and Kiem conclude that lagged values of a REIT portfolio can predict the returns generated by NCREIF.[35] Giliberto [1990] demonstrates that the returns from equity REITs and the NCREIF index have some similar, though unspecified, real estate factors.[36] It should be noted that both of these authors performed some statistical measures to the return series prior to realizing their findings.

Other complications in comparing the returns from publicly held companies and private real estate returns represented by indices such as the NCREIF are:

1. The public market companies may include debt whereas the indexed properties are typically unlevered.
2. The publicly traded companies probably include stock market risk factors in addition to real estate factors.
3. The property companies may carry on development projects, the value of which is reflected on their balance sheets at cost. Shares will therefore reflect an option value to development. The value of the properties in the index, however, will not carry the same value as the option has already been exercised prior to inclusion in the index.[37]

[35] Gyourko and Kiem, pg. 459.
[36] Giliberto, 1990, pg. 262.
[37] Henry and Ward, pg. 208.

Further work performed by Geltner, Rodriguez and O'Connor solidified the link between the public and private markets while addressing many of the concerns outlined above. In order to address stock market noise, while also allowing that many real estate investors have a long investment horizon, they used a holding period of return of five years. They then applied an "un-smoothing" technique to the NCREIF and compared it to the un-levered NAREIT index. They conclude that the indices move in the same general direction with the informational superior NAREIT index leading the NCREIF. Further, they state that their results are "broadly consistent with the hypothesis that public and private real estate are the same thing".[38]

In the United Kingdom property companies (the U.K. equivalent of REITs) do not have a tax advantage over other businesses. The main business focus of the property companies are similar to REITs in that they acquire and manage property.[39] Barkham and Geltner perform a similar analysis as Geltner et al. in unsmoothing the Jones Lang Wooten (JLW) index for the UK.[40] As of 1995, the JLW included approximately 200 properties valued at £500 million. The authors recognize that this is a small sample, but point out that the statistical characteristics of the index are highly correlated with other indices.[41] They then compared the "un-smoothed" JLW to the unlevered FTA Property Index.

In analyzing annual returns, Barkham and Geltner [1995] conclude that, unlike the U.S. market, the public market in the U.K. does not lead the private market. They postulate the reasons for this are that, unlike a comparison between the U.S. REIT market and NCREIF, the property types in the FTA Property Index and the property companies themselves are of the same type and are geographically concentrated. Further, a larger share of properties has been securitized in the U.K. than the U.S.[42]

Interestingly, the property companies in the U.K. traditionally trade at a discount to net asset value (NAV), the reasons for which are not clearly understood.[43] Further study by Barkham and Ward explore various company specific reasons (e.g. unrealized taxes, quality of management, liquidity

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[38] Henry and Ward, 1995.
[39] Barkham, 1995, pg. 91.
[40] Barkham and Geltner, pg. 22.
[41] Ibid. pg. 23.
[42] Barkham and Geltner, pg. 42.
[43] Barkham, 1995, pg. 92.

etc.) and "noise traders" who miss-price the underlying assets. They conclude that, while all of the above have some relation to the observed variation, the studied factors do not fully explain the discount.[44]

In conclusion, researchers have confirmed a reasonably intuitive issue; the returns generated by privately held real estate and those generated by publicly traded companies whose business is primarily owning and managing real estate, are linked and move in essentially the same manner. While not necessarily intuitive, it has also been shown that the public and private markets in the United Kingdom are more or less contemporaneous, whereas they are not in the U.S., implying that the private market in the U.K. is quicker to impound information than its U.S. counterpart.

A further conclusion is that the properties represented by the analyzed public and private markets in the U.K. are probably more homogenous than in the U.S. This should bode well for our study, as in addition to studying the U.K. market as a whole, we will be further segregating it by sector. Should our research technique be applied to the U.S. market, some adjustments may be needed to the property groupings, within both the public and .private indices, in order to make them more homogenous.

2.4 Hedging: A Review

Hedging is a technique to offset particular sources of risk as opposed to searching for the optimal risk-return profile for an entire portfolio.[45] Often times, hedging strategies are employed by companies to negate risks that are not associated with their core business, but are inherent in performing their business on a day to day basis. For example, the profitability of a manufacturer that exports products may be affected by currency exchange rate risks in addition to the risks intrinsic within the manufacturing business. If properly hedged, the currency risks can be managed, thereby allowing the company to focus on its core competency.

Alternatively, hedging can be used to lock in anticipated profits or costs. It is not uncommon in the agricultural business to enter into futures contracts to control income/expenditures many months hence. That is, a farmer who has contracted to deliver grain in six months may enter into

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[44] Barkham and Ward, 1996.
[45] Bodie, Kane and Marcus, pg. 833.

the short (opposite to that of holding the asset) position of a six month future contract. As the price moves either up or down over the next six months, the profit or loss of the long position (requirement to deliver the grain) will be offset by the short position in the futures contract. The farmer will not be subject to the vagaries of the spot market in six months, but will have hedged his position and predetermined his profit. This technique is known as a *short hedge*, that is, one in which the party already owns the asset and expects to sell it at a future date. The opposite scenario would be a *long hedge* in which the party expects to purchase the asset at some future date.[46]

There is a distinct possibility that the hedge will not be completely effective. This is typically due to one or more of the following reasons:

1. The assets being hedged and the assets underlying the hedge may not be identical.
2. The exact transaction dates may not be known.
3. The hedge may need to be closed out before its natural expiration.

These items lead to *basis risk*, which is defined as the difference between the spot price of the asset and the value of the hedge. If the assets are exactly the same while item 2 is known and item 3 is not necessary, then the basis risk should be zero. The assets are rarely identical however, even in the case of commodities as storage and delivery costs must be addressed. This implies that most hedging is actually *cross-hedging*, meaning that the underlying assets are not identical.[47] When a cross hedging technique is employed, it is unlikely that unexpected changes in the hedge and the asset will be identical.[48] That is, a 1% change in the asset may not relate to a 1% change in the value of the hedge.

This leads to the definition of the *hedge ratio* as the ratio of the size of the position in the hedge to the size of the exposure to the underlying asset.[49] The optimal hedge ratio, h*, is the ratio which minimizes the variance of the hedge portfolio profit per unit of the asset. Referring to Stoll and Whaley [pg. 54] for the derivation it can be shown that:

$$h^* = -\sigma_{ah}/\sigma_h^2 = -\beta$$

[46] Hull, pg. 84.
[47] Bodie, Kane and Marcus, pg. 842.
[48] Stoll and Whaley, pg. 52.
[49] Hull, pg. 95.

where σ_{ah} is the covariance of the asset price with the hedge and σ_h^2 is the variance of hedge. The ratio of the covariance to the variance is also the definition of an assets' beta (β). In a single variable ordinary least squares (OLS) regression, the opposite of h* is the slope coefficient. Further, in a multiple regression the estimated coefficients are the respective hedge ratios for each variable while the intercept term represents the basis risk.

As for evaluating the effectiveness of the hedge, ρ^2, it is defined by Stoll and Whaley [pg. 56] as

$$\rho^2 = 1-\sigma_\varepsilon^2/\sigma_a^2$$

where σ_ε^2 is the variance of the residual term. The effectiveness is also the definition of the adjusted R-squared term in an OLS regression.

An important consideration in constructing a hedge is the time interval over which the change in values should be measured. Conventional wisdom would lead one to consider the shortest time frame that data is readily available. This technique, however, could lead to issues with the error term of an OLS regression. That is, the error term should be governed by the following constraints: $E(\varepsilon_t) = 0$, $E(\varepsilon_t^2) = \sigma^2$ and $E(\varepsilon_t \varepsilon_{t-1}) = 0$. With a shorter time interval, the observations become more random which leads to increased variability and less reliable regression results.[50] The impact of differing time intervals can be evaluated by analyzing the standard error and confidence interval results from standard OLS regressions. A lower standard error term and narrower confidence interval leads to more robust results. Lastly, as the time interval between observations increases, the intercept term representing the basis risk, will also increase. Therefore, the impact of the time interval of the observations must be carefully evaluated with regard to its impact on the error terms, confidence interval, basis risk and overall results.

2.5 The Methodology of Hedging Real Estate

As noted above, there appears to be a link between the returns generated by privately held real estate and the public markets (see Chapter 2.3). One of the implications of this relationship is that it may be possible to hedge real estate risk in the public marketplace. This section explores some

[50] Stoll and Whaley, pg. 58.

of the previous research done in this area. The next section will discuss the results of several market instruments that have been introduced which attempted to create a real estate hedge.

Researchers have taken various approaches to the task of creating a viable real estate hedge. Most seem to agree with Giliberto [1993], however, in that a market driven hedge should be utilized in order to avoid the effects of an appraisal based index (e.g. the RNI).[51] Such a hedge would allow for a better application of modern portfolio theory, for asset allocation purposes, by having a comparable measurement of volatility and covariance with other asset classes. That is, many of the asset classes that real estate competes with for allocation of capital, are valued and traded daily in the stock and bond markets, whereas traditionally real estate is not.

Furthering his earlier work of 1990, Giliberto's technique was to create a hedge based upon the National Association of Real Estate Investment Trusts (NAREIT) Equity Index. Realizing that REITs were stocks and included a significant amount of stock market risk, he created a hedge which included a short position in the S&P 500, in order to remove the stock market's systematic risk. Also realizing that the correlation and volatility between REITs and the S&P 500 may move over time, he allowed the hedge ratio to vary on a monthly basis. Creating the hedge in this manner significantly reduced the stock market effect while still retaining real estate risk.[52] He then compared the results with the reported (i.e. smoothed) RNI, reporting a correlation of .18. He identified the smoothing affects of the appraisal based RNI as a possible culprit of the low correlation.

Kerson [1994] built upon this concept, when he created a "Market-hedged Real Estate Index" (MaREI) hedge in a comparable manner. There were, however some differences. First, rather than using the NAREIT index, he used the Wilshire Real Estate Securities Index (WRE). He also realized that REITs were more strongly correlated with small capitalized stocks than with large capitalized stocks. Therefore, rather than use the S&P 500, he utilized the Russell 2000, which includes firms with capitalization's of $60 million to $590 million with an average of $205 million.[53] While the returns of his dynamic hedge exhibit a relatively low volatility, the trade off

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[51] Giliberto 1993, pg. 97.
[52] Ibid. pg. 96.
[53] Kerson, 1994, pg. 2.

is a high volatility of the hedge ratio, which as he points out, will raise the implicit costs due to transaction costs associated with rebalancing the hedge.[54]

Riddiough [1995] extended these previous approaches further as an student exercise for his "Real Estate Capital Markets" class at MIT's Center for Real Estate. First, the RNI was "unsmoothed" in an attempt to determine the "true" underlying returns. Second, the U.S. market was divided into geographic regions to address the importance of the regional impact of economic drivers. Several teams of Riddiough's MIT/CRE students used an approach similar to Kerson in compiling their hedge. One team used a basket of REITs that were based in the region being studied (in lieu of an overall index as used by Kerson), along with a short position in the Wilshire 4500, reporting an R-square of .61 on a static five year period. Riddiough concludes that the process of creating a hedge may be further enhanced by refining the geographic and property type selection technique coupled with a more sophisticated econometric approach towards compilation of the hedge.[55]

As for the impact of the above on our thesis, as was shown in Chapter 2.2, the returns from commercial real estate in the U.K. exhibit a stronger link to property sector as compared with either geographic or "economic driver" location. As will be discussed in the next chapter, the IPD index will be unsmoothed to remove the affects of appraiser uncertainty and the inherent lagging of the index. The process of selecting the hedge components will also be presented.

2.6 The History of Hedging Real Estate

Measuring returns on an ongoing basis for privately held real estate has proven to be challenging as was discussed in greater detail in Chapter 2.1 of this paper. Even allowing for the difficulties in measuring returns, numerous researchers have demonstrated that real estate should be included in a well diversified investment portfolio. There are, however, several practical problems associated with implementing a strategy of direct investment in commercial real estate:[56]

1. The lumpiness, magnitude of transaction costs and management costs of direct investment limits participation to those with sufficient wealth.
2. The liquidity of real estate is often inverse as to when its needed. That is, when the demand for liquidity is high is often when its availability is quite low.

[54] Kerson, 1994.
[55] Riddiough, 1995, pg. 94.
[56] Riddiough, pg. 88.

3. Lack of tradable instruments precludes owners from diversifying away exposure in an efficient manner.[57]

If a reasonable and liquid hedge were found for commercial real estate, investors could gain exposure to the property markets without actually purchasing real estate. Further, owners could selectively manage their property risks by creating synthetic options. Some optimistic authors went as far as to state:

> "The economic significance of index-based real estate derivative markets, if they were to become well established, could well be much greater than that of all financial derivative markets established to date combined."[58]

While the market appears ripe for hedging instruments, several previous attempts in both the U.S. and the U.K. have either failed outright or met with lukewarm response by market participants.

In the United States for example, the Chicago Board Options Exchange (CBOE) began trading index options on a price weighted REIT index comprised of 25 REITs (the RIX Index) in February 1995. The intent was to provide investors with a daily traded mechanism to hedge real estate risk. When the index was assembled, most of the largest (as measured by market capitalization) REITs were included. Through the end of 1995 however, the trading volume was very light (refer to Appendix I). Since the index is comprised of a diverse pool of REITs including representation from the office, self-storage and health care sectors, it would be difficult for an investor to hedge or replicate any particular sector or geographic region using this particular investment tool.

An alternative to hedging in the public markets was taken by Aldrich, Eastman and Waltch (AEW), a pension fund advisor, and Morgan Stanley 1993. A client of AEW's needed to offset a specific real estate risk, but did not wish to actually sell the assets at that time as a substantial loss would have been incurred. AEW and Morgan Stanley arranged a swap exchanging the returns generated by the Russell NCREIF Index (RNI) with the LIBOR less about 50 basis points. The swap was unusual in that the RNI has certain "self-predictive" powers, is appraisal based and is published only quarterly (refer to Chapter 2.1 for additional discussion). The above notwithstanding, both parties are reportedly satisfied with the swap two years later. According to one of the original advisors, however, no additional swaps have been arranged.

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[57] Kerson, pg. 1.
[58] Case, Schiller, and Weiss, pg. 91.

Bankers Trust (1994)[59] and Salomon Brothers (1993)[60] also tried an innovative approach to formulating a hedge for real estate risk. They created their own indices built out of exchange-traded REITs, REOCs and small-cap stocks. While they take somewhat different tacks, they both consider that the public markets may be a better indicator of the value of real estate than the RNI. The Bankers Trust approach, in particular, appears to be an attempt to generate interest and business in their "Market-hedged Real Estate Index" (MaREI) as a tradable investment tool. They viewed the MaREI as perhaps being a better way "to capture a pure play on commercial real estate than (does) the RNI...".[61] According to a representative of Bankers Trust, the index has not been successful in the marketplace.

In the U.K., The London Futures and Options Exchange (FOX) introduced four property futures contracts in May 1991. They were:[62]

1. A residential property contract based on the NAHP index.
2. A mortgage interest rate (MIR) contract.
3. A commercial property capital values contract based on the Investment Property Databank (IPD) commercial capital value index.
4. A commercial property rents contract based on the IPD commercial rent index.

Unfortunately, the contracts did not reach an economically viable level of trading volume and were removed from the market in October 1991, amid charges that the prices and trading volume were being artificially maintained.

More recently in the U.K., Property Income Certificates were issued by BZM Investment Management Ltd. in 1994. The returns from these securities were tied to the IPD property index. Structurally, the securities were configured in a manner similar to a closed end fund. However, BZM erred when it announced that additional securities of the same class would be issued at a future date. The investors were not pleased, and the subsequent issuance fared poorly.[63]

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[59] Kerson, 1994.
[60] Giliberto, 1993.
[61] Kerson, pg. 8.
[62] Patel, pg. 343.
[63] Henry and Ward, pg. 207.

The above attempts at creating market instruments that would facilitate the hedging of real estate risk highlight some of the difficulties in both the public and private markets. Traditionally, real estate is neither traded nor valued frequently, as compared with the publicly traded debt (bond) or equity (stock) markets. When firms have created "new" indices to value real estate in the publicly traded markets investors have been reluctant to participate. This is probably due to a combination of how the indices were compiled, a certain skepticism that the new indices in fact represented real estate, an inability on the part of the investor to address specific risks, and the realization that the index sponsors may simply be creating tools to generate business for themselves.

As for private attempts to hedge, we are only aware of one (the AEW/Morgan Stanley swap). While this approach may be successful on a limited, case specific basis, finding willing counterparties to assume specific real estate risk will remain a difficult obstacle.

2.7 Implications and Innovations

The development of a successful hedge for real estate returns must be based on a widely accepted and understood methodology for measuring those returns. If an appraisal based index, such as the RNI or the IPD is to be used, it must be adjusted to account for its inherent problems. Moreover, the index should be disaggregated to allow investors to address specific investment risks.

The components of the hedge should be widely traded and valued by the market on a daily basis. This would assure that the market efficiently impounds information into the hedge's value and would aid in maintaining its liquidity. In addition, the hedging instrument should allow individual investors the flexibility necessary to meet the specific requirements of their investments. Unless a hedging instrument is flexible enough to meet the specific needs of individual investors and is fully understood and accepted by the marketplace, investors will be reluctant to utilize it and it will suffer from thin trading volume. By utilizing only currently available publicly traded securities, many of these problems that have plagued other approaches would be avoided.

Our approach will utilize only existing financial instruments and thereby avoid the problems associated with the creation of new instruments and having to convince the marketplace of their viability. This was the problem that faced the FOX and that is currently facing the CBOE. In addition, because investors require hedges that are relatively specific to their investment risks, it will be difficult for these types of index exchanges to ever fully satisfy the criteria necessary to meet investors' needs.

The use of publicly traded equities overcomes the problem of liquidity by the very nature of utilizing only the currently existing public markets, where trading volume is high and prices are, at a minimum, priced to market daily. Furthermore, it would allow the development of specific hedges for specific real estate investment risks. No matter how unique the required hedge may be, since the only "counterparty" necessary to implement it will be the public equity market, this would not presumably present a problem.

Another innovation of our approach will be to utilize the spatial requirements of a company and not its capitalized value, to determine the proper weightings within the hedge. This was done in order to directly relate the use of real estate to the impact a company may have on the real estate market. In the past, most similar studies have utilized the capitalized value of a company as a proxy for the company's size and impact upon the real estate market, even though there is no apparent direct correlation between the two. In our study, employment data was used to rank the largest end users of real estate in the U.K. market and the returns for these companies were then used in establishing the hedge. This methodology allows each company an equal weighting, initially, which is subsequently adjusted through the regression process described in the next chapter.

Chapter 3: Development of a Static Replicating Hedge

As indicated previously, this thesis involves a two stage process through which we will attempt to first replicate real estate returns using publicly traded securities and second, to apply the hedge for estimating future real estate returns. This Chapter will discuss the methodology followed to establish a static or replicating proxy for real estate returns. Chapter 4 will discuss the development of the predictive hedge.

3.1 Methodology

Before the development of any type of hedging instrument can be addressed, it must first be established that real estate returns can, in fact, be reasonably replicated utilizing only publicly traded equities. In order to establish this, we sought to develop a proxy of carefully selected, publicly traded equities that demonstrated a significant correlation with the U.K. real estate market's "true returns." This replicating proxy will be developed, ex post, utilizing historical real estate and stock market monthly return data, over a five year period of time.

The development of the replicating or static proxy for the U.K.'s real estate returns involved a three step process as follows:

1. Unsmoothing the IPD Index to establish the "true returns" of the underlying real estate asset.
2. Choosing the equities that would be used to establish the return proxy.
3. Performing regression analysis to test the proxy's correlation with the unsmoothed IPD return indices and to determine the proper weighting for each of the individual equities within the proxy.

3.2 Unsmoothing the IPD Index:

Fundamentally, appraisal smoothing results from the manner in which appraisers arrive at their individual property valuations. Because actual transactions in property investments are relatively infrequent, appraisals must rely on estimates of market value based upon sales of comparable properties. However,

> "...because they have incomplete current information, valuers may be influenced by past valuations of the subject property or by past transaction prices of comparable properties...(resulting) in the contemporaneous valuation containing components of the past market values mixed with the true contemporaneous market value, which induces a lagging and smoothing within the aggregate index."[64]

The U.K. real estate market has a variety of property indices that are constructed for the purpose of establishing returns for annual, quarterly and monthly periods, as well as on a sector and regional basis. The Investment Property Databank (IPD) Monthly Index was utilized for this thesis because it contains detailed monthly return data and is disaggregated into three industry categories. In establishing a useful dynamic hedge for property returns (as will be discussed in Chapter 4), we felt that the shorter monthly return series would allow investors the ability to adjust their hedges more frequently and would therefore be more viable. In addition, since the index is disaggregated into three sectors (industrial, office and retail), we were able to look at each sector as an independent return series, which could allow investors to establish more specific property hedges.

[64] Barkham and Geltner, 1994

As discussed earlier, the U.K. market is relatively geographically homogenous and we did not analyze the data on a geographical basis.

For the purpose of this thesis, we analyzed only the capital appreciation component of the index, because as noted earlier, this aspect captures the majority of the index's volatility. The IPD measures capital appreciation as the increase in the value of the properties, net of any capital expenditure, expressed as a percentage of the capital employed during the month:

$$\frac{\Sigma\ i(CV_{it} - CV_{i(t-1)} - C_{it})}{\Sigma\ i(CV_{i(t-1)} + C_{it})} * 100\% = \text{IPD monthly return}$$

Where CV_{it} is the capital value of property i at the end of the month t, and C_{it} is the cost of all capital expenditure on property i in calendar month t, less any capital receipts.

The IPD Monthly Index is unique, in that each individual property is appraised monthly by one of seventeen independent surveying firms.[65] The frequency of the monthly appraisal and the fact that the majority of the contributing funds are valued at the end of each calendar month, should reduce the influence of temporal aggregation that is evident with indices that rely on annual or even quarterly external appraisals.

Although the reported monthly returns (see Exhibit 3.1 below) from the IPD are relatively volatile (as compared to the RNI), it is apparent from Exhibit 3.2 that the IPD Monthly Indices are relatively smooth over time. This is to be expected due to the fact that the indices are valuation

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[65] The IPD Monthly Index consists of the property portfolios held by property Unit Trusts, Unit Linked Insurance Funds and Managed Pension Funds which are valued monthly. All commercial properties held in the U.K. and Ireland by these funds are covered, except those that are purely residential or agricultural. Hotels, leisure facilities, medical premises, car parks and development sites are also excluded.
IPD has adopted certain conventions in the construction of the IPD Monthly Index. The majority of the contributing funds are valued at the end of each calendar month. It is therefore assumed that all valuations are at this date. This is also the case for all income and expenditure data. Monthly capital expenditure and capital receipts are included, but revenue expenditure (except management costs for rent collection) are excluded from the calculations. Actual transaction and management costs are either supplied by the funds or, when not available, are estimated by applying standard percentages.
Income calculations use net income, which is gross rent receivable less any management cost (rent collection fee) and ground rent. In the case of rent reviews on reversionary properties, the estimated rental value is entered at the time of the review and held constant until the review is settled, when the new rent is entered without any retrospective modification. For over rented properties, the existing rent is held constant.
The Index is based upon the performance of standing investments only. New acquisitions and development properties are only included two valuation months after their purchase date or, in the case of developments, the date of practical completion. Source: Investment Property Databank Ltd.

based and are therefore subject to the smoothing behavior as described above. As noted, the tendency for appraisers is to rely on the previous period's valuation as a benchmark for the current period's valuation due to the lack of contemporaneous transactions. Therefore, it was necessary to unsmooth the return index in order to remove this backward looking bias and to better reflect the true volatility of the returns.[66]

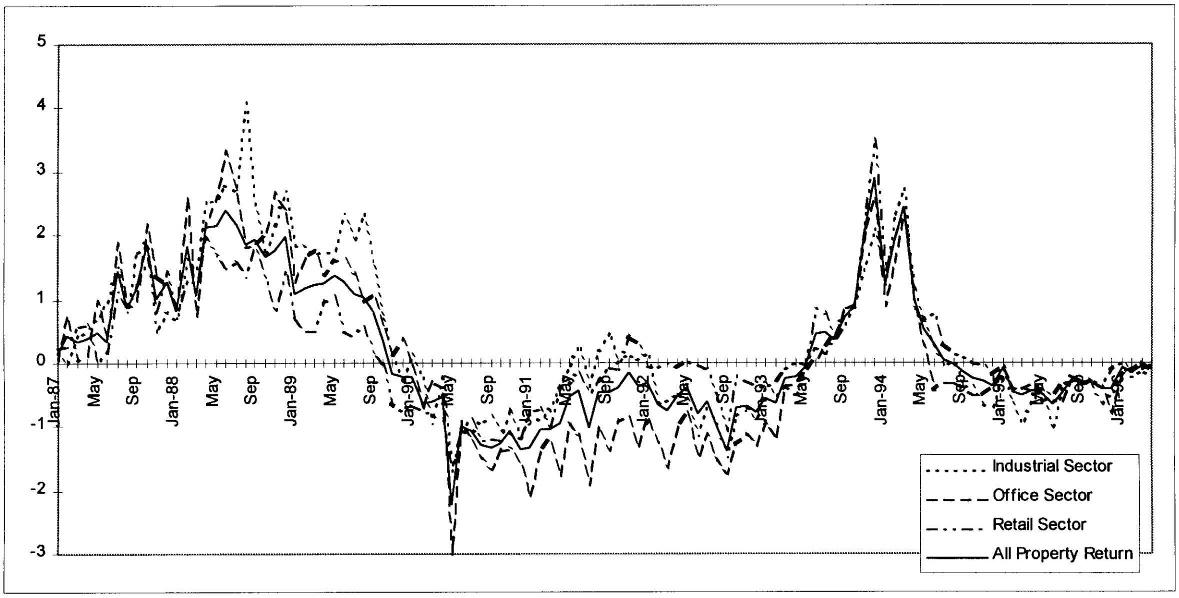

Exhibit 3.1: IPD Monthly Reported Returns

[66] Note that direct comparisons between this paper and other research (e.g. Barkham and Geltner, 1995) need to be made carefully as we are analyzing monthly data whereas typically others have used quarterly or annual data.

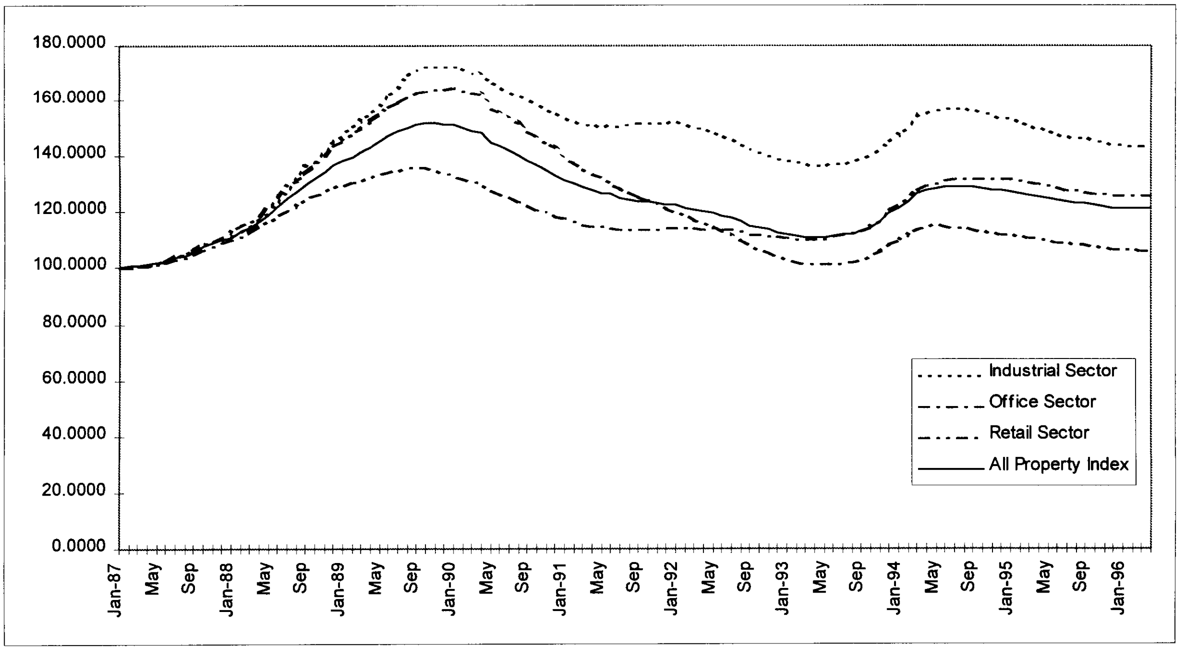

Exhibit 3.2: IPD Monthly Reported Indices

Utilizing the methodology described by Fisher, Geltner and Webb[67] we unsmoothed the monthly capital appreciation return data from the IPD for the three sectors, as well as for the All Property index. This was done for the period of January 1987 through April 1996. In order to apply Fisher, et. al.'s methodology, the first step was to determine the most appropriate lag periods, based upon statistical analysis and what is observed about appraisal behavior. As a first step diagnostic we analyzed the correlogram for each of the return series. The correlogram indicates the relative magnitude of the return series' partial autocorrelation. Upon review, it appeared that the majority of the autocorrelation tendencies of the returns could be explained by lagging the index up to three months. Appendix II compares the results for the reported returns and the returns for each series with 1 and 3 month lags.

This was then confirmed by performing an analysis of eight consecutive monthly lags. In order to determine the proper model, we compared the R-squared values for each combination containing variables with significant t-statistics. Because the regression contained lagged time-series variables, the standard Durbin-Watson test is no longer viable.[68] A superior test for autocorrelation in series containing lagged variables is the Ljung-Box Q-statistic. Additionally,

[67] Fisher, Geltner and Webb, 1994.
[68] Pindyke and Rubinfeld, pg. 147.

when comparing the various models we utilized both the Akaike Information Criterion and the Schwartz-Bayesian Criterion to determine the best fit model. These criterion essentially filter out the effects of extraneous terms that may appear in the regression equation. Based on the results, it was determined that the "true returns" would be best represented by lagging the index returns by one and three month periods. Refer to Appendix III for a summary of these results. Exhibit 3.3 below shows the results for the Industrial Sector.

LS // Dependent Variable is IND
Sample(adjusted): 1987:04 1996:04
Included observations: 109 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
IND(-1)	0.767849	0.078674	9.759838	0
IND(-3)	0.154619	0.078769	1.962951	0.0523
C	0.000194	0.000526	0.368514	0.7132

R-squared	0.812081	Mean dependent var	0.003316
Adjusted R-squared	0.808535	S.D. dependent var	0.012038
S.E. of regression	0.005268	Akaike info criterion	-10.46521
Sum squared resid	0.002941	Schwarz criterion	-10.39114
Log likelihood	418.6899	F-statistic	229.0359
Durbin-Watson stat	2.10769	Prob(F-statistic)	0

Exhibit 3.3: Regression Results for Industrial Sector (1 & 3 Month Lags)

[A structural note on the balance of this thesis: Results for the Industrial Sector will be used for exhibit purposes within the body of the text. Results for the Retail, Office and All Property Sectors will be included in the Appendix. The Industrial Sector results are representative of the other sectors.]

As noted above, due to requirements of the types of funds in the IPD Monthly Index, all properties are reappraised on a monthly basis. In addition, anecdotal evidence indicates that a more thorough appraisal of the same properties is performed on a quarterly basis. These two appraisal artifacts would support the statistical results reported above. The tendency for appraisers to rely on the previous period's valuation would cause the index's reported returns to lag the underlying property values, by approximately one month and three months. Lagging the index by these two time periods effectively removed these effects from the returns. Exhibit 3.4 below is a graphical representation of the Industrial Sector regression. See Appendix IV for complete results.

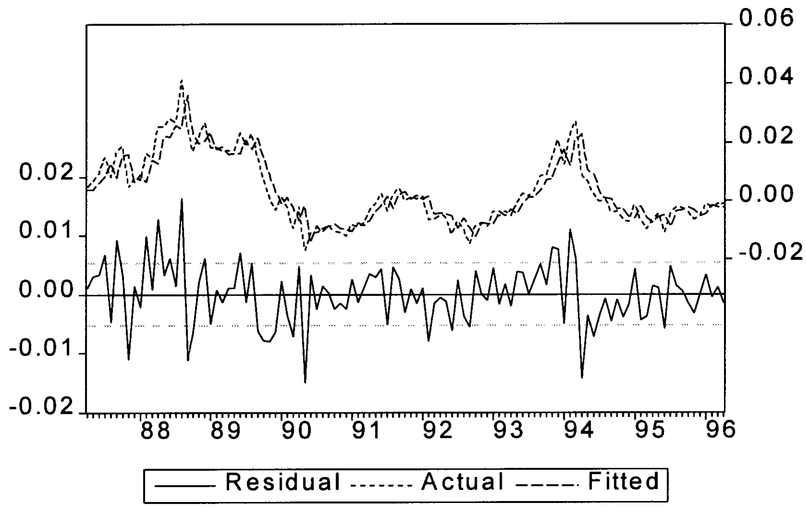

Exhibit 3.4: Industrial Sector (1 & 3 Month Lags)

In order for the returns to reflect the true volatility of the underlying asset, an assumption needed to be made relating the volatility of real estate returns to those found in the stock market. For the purposes of this analysis, we have assumed a stock market volatility of 20% per year, with property price volatility being 75% of this amount. The accuracy of these assumptions are not critical to the methodology we use to formulate the hedge, as these volatility figures do not directly impact the fundamental economic relationships being tested. However, changing the volatility assumptions would affect the weightings of the individual securities within the hedge. See Chapter 5.3 for a further discussion. Next, the "true" unsmoothed returns were calculated utilizing the methodology described by Fisher, et. al. Refer to Appendix V for the results of these calculations. Finally, the unsmoothed returns were used to compile unsmoothed return indices for each sector. Exhibit 3.5 below, shows the resulting unsmoothed return index graphed against the reported IPD monthly return index for the Industrial Sector. Please see Appendix VI for complete results.

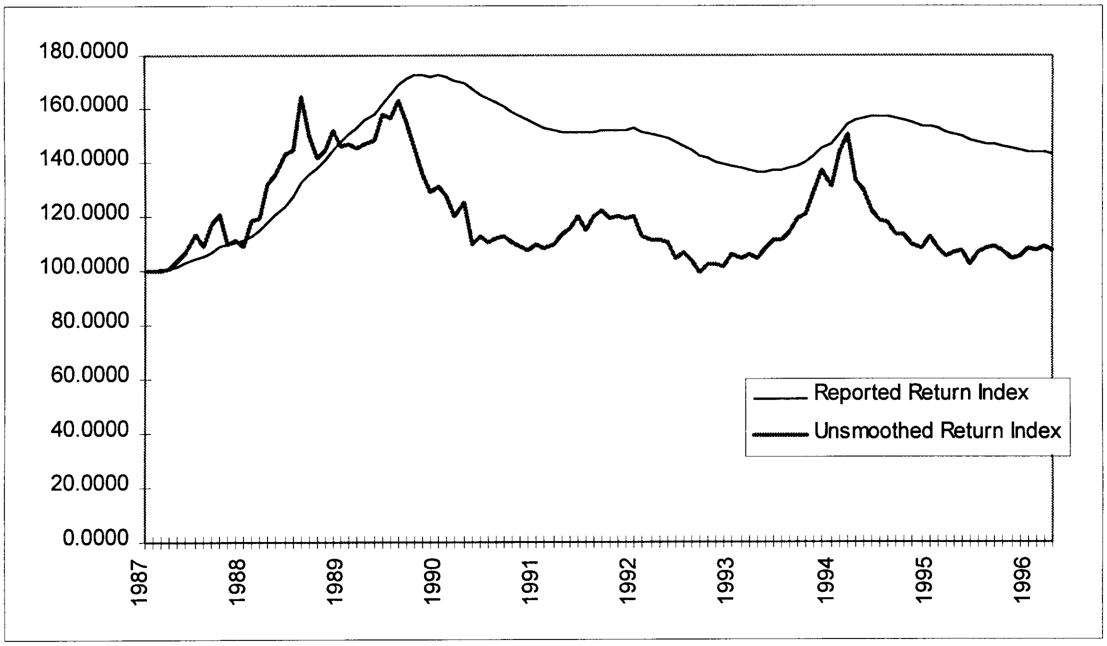

Exhibit 3.5: Industrial Sector Unsmoothed Returns vs. Reported Returns

3.3 Selection Criteria for the Publicly Traded Equities

The next step involved the selection of a representative set of equities that might exhibit an economic relationship to the underlying property values. In order to identify public companies that would have the most significant impact on this relationship, we selected between 60 and 70 of the largest companies for each of the three sectors, based on the number of employees. This produced a total "universe" of approximately 200 equities, which, if our hypothesis was valid, should exhibit a significant correlation of returns with the unsmoothed IPD.

The universe was expanded to include returns for several government bonds to test for relationships between interest rate movements and real estate returns. Earlier efforts in creating a real estate hedge in the U.S. [e.g. Riddiough 1995, Kerson 1994 et al.], included a small basket of securities and an index of a broader portfolio of stocks. The rational for the inclusion of an index, which in these examples was shorted in the creation of the hedge, was to eliminate stock market risk leaving behind only real estate exposure. To test this reasoning, we included the FTSE 100 and the FTA Property indices. Finally, we included a number of Real Estate Operating Companies (REOC's). Since the primary assets of a REOC are real estate, returns generated by the REOC are likely to be linked to the assets generated by those returns.

Price data was then collected and converted into monthly returns for all of the above securities for the ten year period of June 1986 through June 1996. Due to a lack of complete return data for a number of these entities, the data was then culled to result in a total universe of approximately 240 securities. Although this represents only a small percentage of the total number of publicly traded financial instruments in the U.K., we felt that it was representative of the type of entities that should have real estate based relationships. While the inclusion of more companies, (or for that matter, all publicly traded companies), may have increased the probability of discovering higher correlations, we felt that this would also increase the likelihood of spurious associations having nothing to do with any underlying real estate based relationships.

3.4 Stock and Time Period Selection

Once a universe of equities, bonds and indices had been assembled, the next step was to determine how many securities would be in the final hedge and over what time period the replicative hedge would be compiled. Our goal in developing the "best" replicating hedge was to include as few securities as possible while maintaining a significantly high correlation between the two return series, as measured by the regression's R-square value. In addition, we did not want to include any variables that exhibited less than a 95% significance as measured by their individual t-stats. Because there is a tradeoff between the number of variables and the significance level of the replication, a decision had to be made regarding the maximum number of variables (and hence the hedge's transaction costs) and the minimum acceptable efficacy of the hedge. Since including a large number of variables could introduce prohibitively high transaction costs in establishing and maintaining a dynamic hedge, we limited the maximum number of variables to 15 publicly traded securities. At this level we were still able to achieve significant R-squares in the range of mid .80's to low .90's for the different sectors. Reducing the number of variables further, lowered the significance of the replication, while adding more variables improved the results on a marginally diminishing basis.[69]

The next step was to select the length of time over which the static hedge would be compiled. Due to the relatively large number of securities in the regression, we were concerned about degrees of

[69] For example, using 8 securities to replicate the industrial sector produced an R-square of .65 over 60 months. Interestingly, in previous research on the RNI Industrial/R&D Sector, we were able to replicate the return index to 98% accuracy, over a 5-year period (with quarterly increments), using only 9 exchange traded equities.

freedom, if the number of observations were too low. In order to avoid this problem we determined that a time frame of 60 months would be most appropriate.[70]

The time period selected for the creation of the static hedge was limited by the availability of computerized return series for the assembled universe of securities. Unfortunately, prior to approximately 1990, return data was no longer available for a number of the securities chosen for our research. Because of this limitation, we selected 1990 as the first year of the hedge. Using 60 months as the length of the static hedge brought us to December 1994. This allowed us to test the predictive ability of the hedge over a 14 month period, from January 1995 to February 1996.

3.5 The Creation of a Static Replicative Hedge

Using a combination of regression techniques, the selected universe of publicly traded securities was culled to 15 securities for each of the three real estate return sectors as well as the overall property index. We expected that the hedge would include a number of companies that were explicitly related to a particular sector. We were, however, anticipating some cross over of companies into other sectors, due to the homogeneity of the U.K. economy and property market. That is, as the U.K. is essentially a single economy, each of the sectors should be related on a fundamental economic basis. This relationship is evident by analyzing the cross-correlation of the unsmoothed real estate return series depicted below:

	Industrial	Office	Retail	All Property
Industrial	1	-	-	-
Office	0.609	1	-	-
Retail	0.583	0.576	1	-
All Property	0.755	0.903	0.844	1

Exhibit 3.6: Cross-Correlation of Unsmoothed Sector Returns

As shown, the industrial, office and all property indices exhibit fairly strong correlation. The retail sector exhibits weaker, though still strong positive correlation with both the retail and office sectors, and very strong positive correlation with the all property index.

[70] We also experimented with the time period, trying both 48 and 72 month periods as well. As would be expected, the 48 month period moderately improved the results while the 72 month period resulted in a moderate degradation of the results.

The regression results and the fifteen selected securities for the industrial sector are presented below in Exhibit 3.7:

Multiple R	.93908
R Square	.88187
Adjusted R Square	.84160
Standard Error	.01577

Company Name	Beta Coefficient	t-stat	Primary Business Activity
Compass Group	0.265169	-5.807	Industrial Catering contractor
Dalgety, PLC	0.232024	-4.424	Food manufacturer and Dist.
Dawson International	-0.19808	-6.251	Textile Manufacturer
Johnson Group	0.253835	-4.986	Dry Cleaner and Linen Rental
Rank Organisation	-0.276595	-5.46	Holding Company / Manufacturer
Salvesen Christian	-0.130593	-2.913	Food and Brick Manufacturer
Sedgwick Group	0.174113	-6.25	Insurance broker / Property Manager
Smith & Nephew	-0.104951	-2.118	Pharmaceutical manufacturer
Tesco. PLC	-0.253987	-5.72	Food Proprietors
Wolseley, PLC	0.161705	-3.908	Sanitaryware manufacturing
Zeneca Group	0.36809	-4.749	Manufact. of Pharm. and Agriculture
Berisford, PLC	0.086916	-6.688	Prop. dev., Food and Agribusiness
Provident Financial	-0.204466	-4.297	Holding company
Daejan Holdings	0.193277	-3.165	Property company
Town Centre Securities	-0.114242	-2.726	Property company
Constant	-0.002379	-0.988	

Exhibit 3.7: Regression Results for Industrial Sector

In analyzing the securities selected, it is evident that the majority are either companies from the industrial/manufacturing sector and/or property companies. Considering the strong cross correlation between the sectors' returns as seen in Exhibit 3.6, this would appear to support our original hypothesis concerning the relationships between the end users and real estate values. Not unexpectedly, several property companies are included which implies that REOCs do exhibit a correlation with the property index. As for the coefficients, note that about half are negative. This means that in establishing the hedge, the mechanics of which will be discussed in Section 3.6, these securities would need to be shorted. More fundamentally, this means that the fortunes of these companies as reflected by their stock prices, are moving opposite that of the underlying real estate. For instance, financial markets often reward companies by bidding up its stock price for downsizing its work force. This would reduce the company's requirements for space and hence apply downward pressure on associated real estate values, at the same time its stock price is on the rise.

The regression results for both the reported and calculated monthly return series and their associated indices are shown graphically in Exhibits 3.8 and 3.9 for the industrial sector. In analyzing the results it is apparent that in most instances the monthly returns for the unsmoothed IPD and the replicating hedge correspond in both the direction and the magnitude of their movements. Referring to the indices, the same observation can be made, as well as the fact that after approximately four years the index values are effectively equal and remain so for the remainder of the test period. These results indicate that our methodology for creating the replicating hedge was successful. Refer to Appendices VII - IX for the office, retail and all property sectors, the results for which are not appreciably different from those presented below.

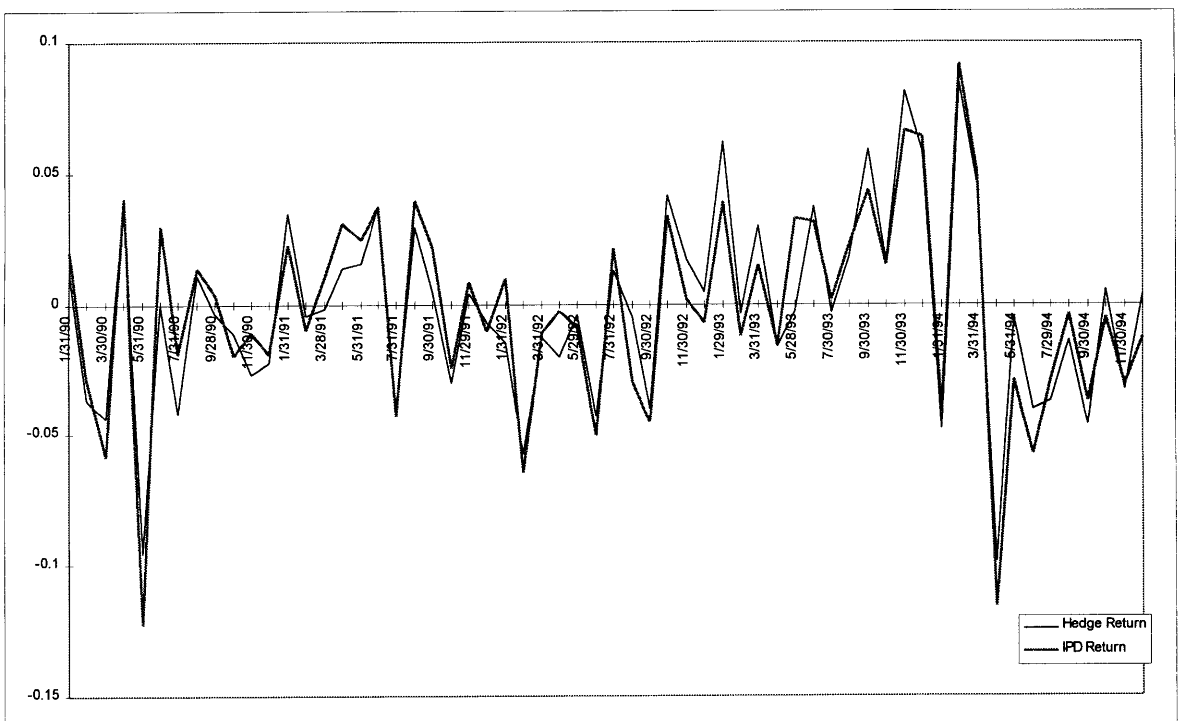

Exhibit 3.8: Industrial Replicating Hedge Returns vs. Unsmoothed IPD Industrial Returns

Exhibit 3.9: Industrial Replicating Hedge Index vs. Unsmoothed IPD Industrial Index

3.6 How the Hedge Would be Purchased

After determining these coefficients, the next step in the process was to convert them into a specific number of shares for each of the securities. The output from the regressions (the coefficients) represent the hedge ratios of each term in the regression. Recall that each dependent variable is the return generated by a particular security over a monthly interval.

Since all of the independent variables have a similar unit of measure (i.e. percent return) and are economically similar (i.e. a share of a security), the coefficients can be directly compared to one another. Each coefficient therefore represents a weighting of the returns generated by its independent variable as compared with the others within the hedge. Keeping in mind that the hedge is return based, each of the coefficients must be multiplied by the amount to be hedged. The resulting product is the value required to be purchased in each security. Dividing this value by the initial security price results in the number of shares of each stock in which a position must be taken. Generally, the formula to determine the number of shares of a particular security would be:

(security hedge ratio * amount to be hedged) / initial security price = number of shares

Again, using the industrial sector as an example:

Company Name	Security Hedge Ratio (Coefficient)	Pounds per Security*	Price as of Jan-95	Number of Shares*
Compass Group	0.2652	2,651,690	3.150	841,806
Dalgety, PLC	0.2320	2,320,240	3.879	598,154
Dawson International	-0.1981	(1,980,800)	1.225	(1,616,980)
Johnson Group	0.2538	2,538,350	2.300	1,103,630
Rank Organisation	-0.2766	(2,765,950)	3.690	(749,580)
Salvesen Christian	-0.1306	(1,305,930)	2.670	(489,112)
Sedgwick Group	0.1741	1,741,130	1.550	1,123,310
Smith & Nephew	-0.1050	(1,049,510)	1.530	(685,954)
Tesco. PLC	-0.2540	(2,539,870)	2.490	(1,020,028)
Wolseley, PLC	0.1617	1,617,050	3.915	413,040
Zeneca Group	0.3681	3,680,900	8.790	418,760
Berisford, PLC	0.0869	869,160	2.280	381,211
Provident Financial	-0.2045	(2,044,660)	2.735	(747,590)
Daejan Holdings	0.1933	1,932,770	11.950	161,738
Town Centre Securities	-0.1142	(1,142,420)	0.990	(1,153,960)
	Total	4,522,150		

* Example is for a £10,000,000 hedge

Exhibit 3.10: Replicating Hedge Calculation

Of course, this is does not imply that the stocks themselves must actually be purchased. Alternative methods such as futures and options could also be used to gain exposure while reducing the up front costs. As for the constant term, it represents the basis risk of the hedge. Notably, the t-statistic of this term is not significantly different from zero, so it can be ignored without affecting the results. While the coefficients determined in the creation of the replicative hedges can not be known prior to December 1994, these coefficients could be used to create a static hedge as of January 1995.

3.7 Conclusions

The purpose of this chapter was to explore the potential for developing a static replicating hedge for the various sectors of the capital appreciation component of the IPD Monthly Index. The first step was to "unsmooth" the index to remove autocorrelation and to capture the "true" returns being generated by the underlying asset. Based upon our analysis of the error terms of the unsmoothed index, we believe that we were successful in removing the affects of autocorrelation from the index.

The next step was to determine a basket of securities which replicated the true real estate returns as measured by the unsmoothed index over a backward looking fixed period of time. This was accomplished using data from January 1990 through December 1994. The innovation of our technique was to let the coefficients of the regression determine the weightings of the securities in the hedge. In similar attempts, others (e.g. Henry and Ward) had predetermined a weighting of the securities before the regression was run. While 15 securities were ultimately selected for each sector, note that in each case all of the securities form a statistically significant portion of the composition of the replicating hedge (in excess of the 95% level of confidence).

The replicating hedge explains around 90% (depending upon the sector) of the variability of the returns of the unsmoothed IPD Index. Referring back to Exhibit 3.8 and 3.9 it is important to reiterate how well the replicated hedge returns and index correlate with the unsmoothed IPD. These results indicate that it is indeed possible to replicate real estate returns using only publicly traded securities.

As we are unaware of any statistical aberrations in either unsmoothing the index sectors or in compiling the hedge itself, we believe that these results are quite strong. The implications of these results will be discussed in Chapter 5.

Chapter 4: Development of a Predictive Hedge

4.1 Methodology

While the results determined above have strong implications for the investment community, they are produced entirely ex post. That is, they were derived using historical data and therefore are not predictive in nature. The intent of this chapter is to extend the methodology and "roll" it into the future in order to predict the returns generated by the unsmoothed IPD Indices. If such a predictive methodology can be developed it would enable investors to manage real estate risk by giving them the ability to hedge future returns.

We analyzed several alternative methodologies for both the All Property and Industrial Sectors. Once again the results for the Industrial Sector will be used for illustrative purposes in the body of the test. The results for the All Property Sector are included in Appendices X - XIV. The methodologies tested for each sector are as follow:

***Extended static replicative hedge*:** This was the simplest hedge we analyzed. In this scenario, we simply multiplied the coefficients of the static replicative hedge for the period of January 1990 through December 1994 by the monthly returns generated by those same stocks, for each month, through February 1996. These results were then compared to the unsmoothed monthly real estate returns. (See Appendices XI and XIII).

***Rebalanced hedge*:** We next attempted to improve these results by rebalancing the coefficients of the same 15 securities (on a monthly, quarterly and semiannual basis) based on a rolling replicative hedge. (See Appendices XI and XIII). This rolling replicative hedge was determined by regressing the returns for the previous 60 month period, for each new month being tested. For example, in order to determine the value of the hedge for the month of February 1995, we regressed the returns of the same 15 securities, which had been determined in the initial replicative hedge, over the period of February 1990 through January 1995. These coefficients were then used to calculate the hedge for February 1995. The process was then repeated for each subsequent month. For March 1995 we regressed the period of March 1990 through February 1995, and so forth, through February 1996. The rational for this approach was that better results would be attained by keeping the static replicating hedge and the predictive hedge periods as contemporaneous as possible. The shorter the lag between the two, the better chance the hedge had of continuing the relationship that was evidenced in the previous 60 month period. It was also felt that since only the ratio of the stocks held in the hedge would change from period to period and not the stocks themselves, this restriction should have lower transaction costs then reconfiguring the entire hedge (see below).

***Reconfigured hedge*:** For this test, we again started with the same static replicative hedge developed in Chapter 3 and then adjusted the coefficients in a similar manner to the rebalanced hedge described above. However, in this instance we did not limit the securities to the same ones as determined by the initial replicative hedge. That is, in each rebalancing period (which again were monthly, quarterly and semiannual) we found the best fit regardless of the components of the previous period's hedge. Ignoring transaction costs, we believed that this hedging strategy would provide the best results. (See Appendices XII and XIV).

4.2 Results of the Predictive Hedges

In order to analyze the results of the hedges described above, we measured the monthly error terms between the unsmoothed IPD returns and the returns from each predictive hedge. We were then able to compare the results for each methodology across similar time periods. We were also able to calculate and compare the average error terms and the standard deviations for each over the entire test period of 14 months. The results are tabulated below in Exhibit 4.1:

Date	Replicative Hedge	Rebalanced Monthly	Rebalanced Quarterly	Rebalanced Semiannully	Reconfigured Monthly	Reconfigured Quarterly	Reconfigured Semiannually
1/31/95	0.0379	0.0379	0.0379	0.0379	0.0379	0.0379	0.0379
2/28/95	-0.0353	-0.0336	-0.0353	-0.0353	-0.0334	-0.0353	-0.0353
3/31/95	-0.0137	-0.0116	-0.0137	-0.0137	-0.0103	-0.0137	-0.0137
4/28/95	0.0230	0.0243	0.0244	0.0230	-0.0007	-0.0007	0.0230
5/31/95	-0.0090	-0.0047	-0.0043	-0.0090	-0.0404	-0.0158	-0.0090
6/30/95	-0.0800	-0.0769	-0.0847	-0.0800	-0.0601	-0.0821	-0.0800
7/31/95	0.0596	0.0632	0.0627	0.0627	0.0829	0.0829	0.0829
8/31/95	0.0819	0.0837	0.0787	0.0787	0.0232	-0.0305	-0.0305
9/29/95	0.0089	0.0158	0.0173	0.0173	-0.0179	-0.0129	-0.0129
10/31/95	-0.0137	-0.0222	-0.0241	-0.0110	0.0493	0.0493	0.0264
11/30/95	-0.1348	-0.1112	-0.1108	-0.1201	-0.1016	-0.0617	-0.1187
12/29/95	-0.0088	-0.0226	-0.0144	-0.0137	-0.0288	-0.0260	0.0058
1/31/96	-0.0093	0.0046	0.0036	0.0036	0.0932	0.0932	0.0932
2/29/96	-0.0392	-0.0072	-0.0110	-0.0110	0.0301	0.0273	0.0273
Average	-0.0095	-0.0043	-0.0053	-0.0051	0.0017	0.0009	-0.0002
St Deviation	0.0548	0.0509	0.0511	0.0518	0.0546	0.0513	0.0569

Exhibit 4.1: Monthly Error Terms: Unsmoothed IPD vs. Predictive Hedges

As can be seen, the error terms vary considerably on a month to month basis, from less than 0.004 to .1348 as measured as the differences between the reported and calculated IPD index values. However, the largest monthly error terms occur within the same time periods for each methodology used and appear to be grouped primarily in the months of June through August and particularly in the month of November. This consistency could well indicate that the hedge is not reacting well to certain movements within either the IPD index or perhaps specific stock market shocks. This is confirmed somewhat by analyzing the following Exhibit 4.2 which shows a graph of all of the error terms together.

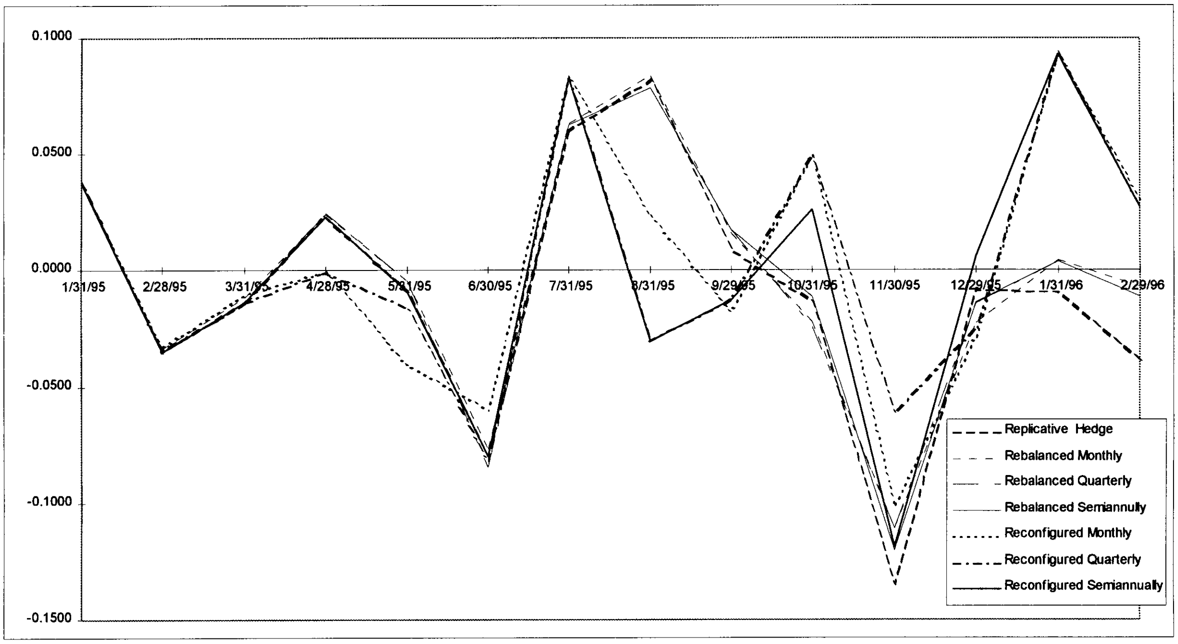

Exhibit 4.2: Comparative Error Terms

While this graph is difficult to read, the following general relationships can be observed:

1. The errors from the replicative and rebalanced hedges move in the same manner.
2. The errors from the reconfigured hedges also move together.
3. The errors from all of the hedges generally move together.

A possible explanation for the volatility of the errors lies in the overall accuracy of the replicating procedure. Recall that the R-squared terms of the regressions used to create the hedges were generally between .85 and .90. Recall also that the R-squared terms of the unsmoothing technique were typically below .80 (refer to Appendix III). The observed errors shown above probably a reflection of the error terms left over from the regressions. These errors, therefore, demonstrate an intrinsic risk of our hedging strategy.

However, it is important to note that the intrinsic risk demonstrated above is most prevalent in the short term, month to month basis. If the error terms are viewed as a moving average or if the hedge results, as measured by the cumulative or average error terms, is viewed on a long term (6 month) basis, the apparent risk is greatly reduced. In fact, over the 14 month test period the average error terms are all below 0.01, and are below 0.002 for all of the reconfigured hedges for the Industrial Sector and are all below 0.003 for the All Property Sector. (See Appendix X). The fact that these error terms tend toward zero indicates that there is not a systematic problem with the methodology used to compile the hedge. For comparison the absolute value of the averages of the error terms are plotted below in Exhibit 4.3:

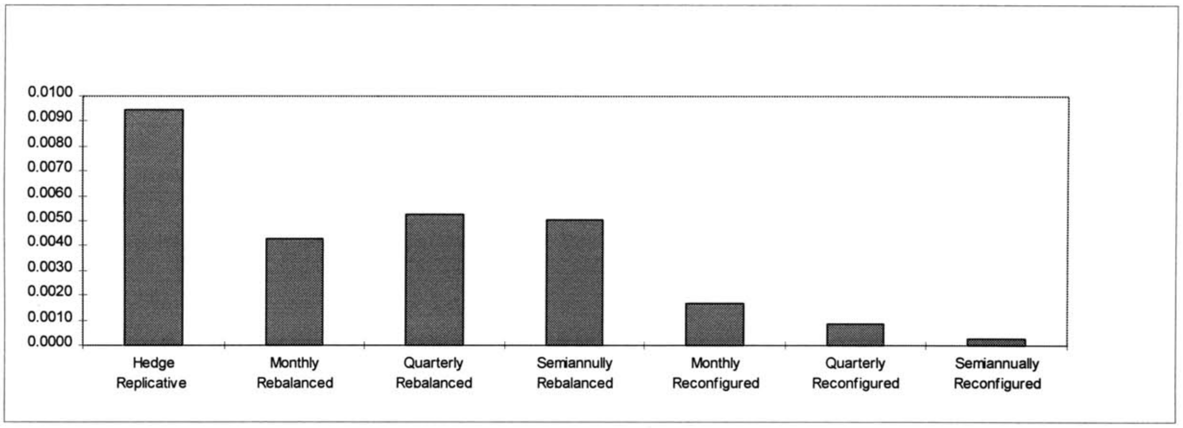

Exhibit 4.3: Absolute Values of Error Terms Averages

As shown above, generally the strongest results were generated by reconfiguring the hedge. Also, rebalancing the hedge ratios produced stronger results than the static hedge. These results were consistent with the idea that incorporating more data should produce better results. However, the best overall results were arguably produced by reconfiguring the hedge on a semiannual basis and not on a monthly basis. Initially we had expected the we would achieve better results the more often the hedge was reset, due to the fact that this would incorporate the most recent data. A possible explanation could be that the observations within the shorter time period are more volatile and random and therefore could be producing less reliable results (refer to Chapter 2.4 for a more in depth discussion). Another possible explanation could be that apparently our hedging strategy does not completely link real estate and public security markets.

Exhibit 4.4 below shows the results of the predictive returns from the semiannually reconfigured hedge as a continuation of the industrial index. Note that while the hedge does diverge from the unsmoothed index for a short period of time, it converges towards the IPD within several months.

While we would like to believe that this apparent convergence is due to an economically justifiable hedge, the results do not warrant such a strong endorsement. Additional data and observations are required to substantiate this type of argument. (See Appendices XI - XIV for complete results).

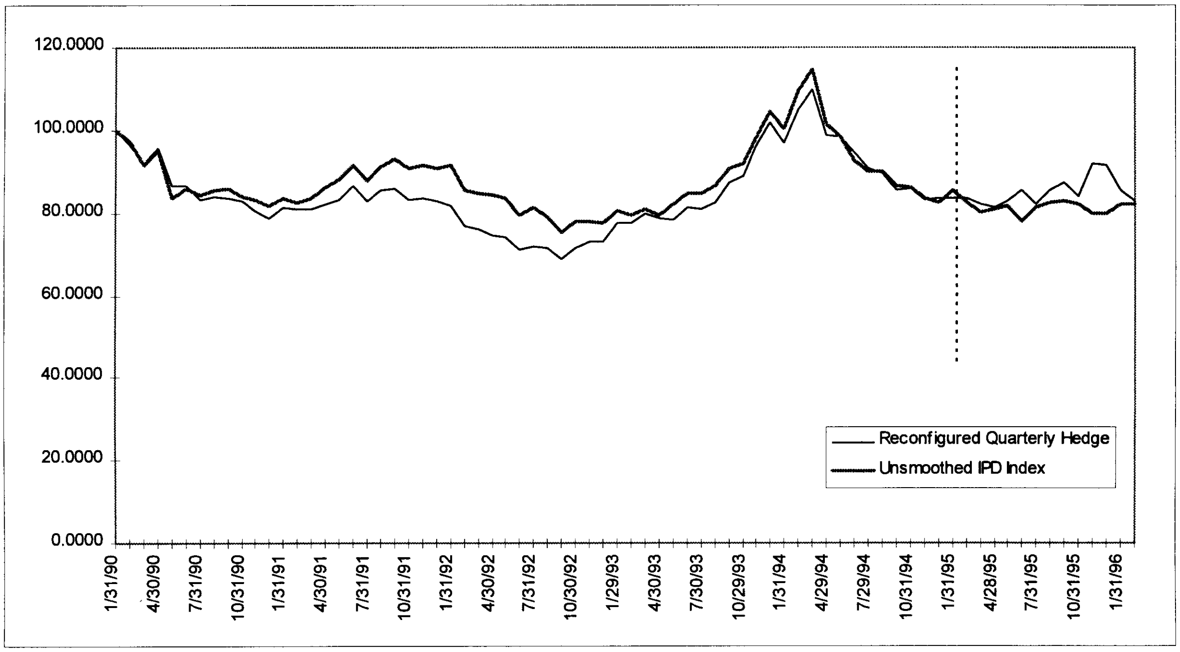

Exhibit 4.4: Predictive Hedge, Reconfigured Semiannually vs. IPD unsmoothed Index

4.3 Conclusions

The objective of this chapter was to create a predictive hedge for the unsmoothed IPD. As the returns generated by the various hedging scenarios we tested deviated from the reported returns by over 8% in some months, our results are inconclusive. On a short term basis, these results are not very strong, and leads us to conclude that the hedges do a relatively poor job of predicting the returns generated by real estate on a month to month basis.

However, over a longer period of time, the error terms effectively average to zero, as would be expected if there were an underlying economic justification for the relationship. When compiling an index of the returns, the hedge values generally tend to follow the IPD Index over the longer term.

Chapter 5: Summary and Conclusions

Throughout this thesis we have sought to study two basic ideas; whether or not the returns from real estate be replicated and whether they be predicted using publicly available securities. We believe that the statistical analysis of our results, as presented above, demonstrates that real estate returns can be replicated. The ability to predict the returns was less conclusive, although we make an argument that overall indices of real estate and the predictive hedges generally do move together. Discussed below are our interpretations as to the implications of these findings.

5.1 Replicating Real Estate Returns

Our first line of investigation sought to determine if there was a quantifiable link between unsecuritized commercial real estate returns and publicly traded securities. We hypothesized that there should be a strong link between the financial well being of the real estate's end users and the value of the real estate itself. Accordingly, we compiled a list of the largest users of real estate by using the number of employees as a proxy. In doing so, we limited ourselves only to publicly traded companies. We also included various stock indices, government bond returns and property companies to attempt to capture additional components of the return series. Our results indeed indicate a strong relationship between the stock returns of the largest users and property companies with the returns generated by real estate.

If one accepts the rationale used to recover the true underlying real estate returns (i.e. the unsmoothing techniques), then it can be stated that approximately 85% to 92% of these returns can be explained by the combination of 15 carefully selected publicly traded securities. Furthermore, these returns could be obtained without the illiquidity, property management expense and idiosyncratic exposure inherent to owning the physical asset. The implications of this could have far reaching impact on the way real estate is viewed by investors. As discussed in the introduction to this thesis, it is a widely held belief that investing in real estate benefits a stock and bond portfolio by lowering the portfolio's overall volatility per unit risk through the benefits of diversification.

However, if real estate returns can be replicated using only contemporaneously existing publicly traded securities, then in fact, real estate does not bring any diversification benefits to a portfolio that are not already available in the security markets.

The strategy used in our research involved the use of only publicly available information for both the real estate and security returns. The drawback to this type of data involves the use of appraisal based real estate indices as a proxy for the underlying asset returns. As discussed in Chapter 2, it is widely accepted that these indices do not directly reflect the true returns to real estate as reported. Although we feel the methodology followed to recover the "true" returns is an improvement over the reported returns, it is impossible to quantify how accurate these true returns may be. Since our research utilized these unsmoothed returns as a benchmark, our results are only as accurate as the unsmoothing techniques themselves.

5.2 Development of a Predictive Hedge

In developing a replicative hedge, it is important to note that it can not actually be purchased as the coefficients are determined ex post. If an investor wishes to either hedge real estate risk or use a basket of securities as a proxy for real estate, the components must be known ex ante. The objective of a predictive hedge is to predetermine the components and their weightings.

As described above in Chapter 4, the methodology investigated herein allowed for a number of variations to be tested, including different time periods for readjusting the hedge portfolio. In testing these options, we initially thought that there would be a positive correlation between the accuracy of the hedge and the frequency with which it would be readjusted or reconfigured. That is, the more frequently the hedge was adjusted the more current the data would be, and therefore the stronger the anticipated results.

Our results, however, did not explicitly confirm this. We found that though the results for the reconfigured hedge portfolio were superior to the rebalanced and static hedge, they did not improve with greater frequency of reconfiguration. One possible explanation for this lies in the unexplained components and randomness that exists in a hedge that is able to replicate the underlying returns only to approximately 90%. Reconfiguring the portfolios monthly, or even quarterly, appears to increase the differences between the reported and calculated return values.

From our results, it appears that reconfiguring the hedge does significantly lower the error terms and that the best results are attained by allowing the hedge to remain in place for approximately six months at a time. This methodology resulted in an average error term of only 0.002 over the 14 month test period.

We based our analysis on the measurements of the differences between the unsmoothed monthly returns and the predicted monthly returns of the hedge. In analyzing these error terms for the various methods described above, we observed that although there were differences between the accuracy of the different methods, all methods averaged less than a 0.01 error over the 14 month test period. For the All Property Sector, the results averaged less than 0.003. However, with standard deviations of more than 5.0% the hedges are quite volatile and may not be a viable tool for a short time frame investment.

In summary, our results in developing a hedge to predict the returns generated by the IPD are modest when viewed on a month to month basis. However, when comparing indices, the hedge and IPD seemingly move roughly together. An investor wishing to use this type of hedge would either need to accept the short term return deviations or be willing to hold onto the hedge for several months.

5.3 Issues with Implementation

Probably the largest issue with implementing our findings will be the use of an appraisal based index as a proxy for real estate and economically justifying the unsmoothing techniques to investors. Confirming any underlying relationships to real estate returns will always be only as accurate as the measurements used for those returns. Until a widely accepted and accurate measure of real estate returns can be established, this question will continue to cast a shadow on empirical real estate related research. Specific to our research on the U.K. market, was the lack of readily available long term data. Unfortunately, this limited our ability to test the dynamic hedges over a longer period of time. Additionally, an investor may not agree with our assumptions of 20% volatility for the stock market and 75% of this amount for the property price volatility. Differing these assumptions will not affect either the methodology or the resulting selection of securities. Of course, what will change will be the hedge ratios which in turn will alter the number of shares of a given security in the hedge.

With regard to previous attempts at hedging real estate, most have tended to suffer from lack of acceptability in the marketplace. In addition, these previous approaches have lacked the ability to create specific hedging instruments for specific idiosyncratic risks by relying on a newly composed index or security. These short comings have invariably lead to a lack of a market viability as evidenced by thin trading volume.

Our technique was different. First, we segregated the market into sectors, which could allow investors the ability to hedge more specific risks. Second, the securities needed to create the hedge are publicly available stocks that have significant trading volume of their own accord. This implies that an investor who wishes to hedge, for example, the industrial sector may do so by entering the public securities market without having to rely on a particular counterparty. This will assure liquidity. Third, we utilized return data, as opposed to prices, when running our regressions.

Transaction costs are also an issue. On the one hand, in terms of utilizing a replicating hedge to achieve the apparent diversification benefits of real estate in portfolio management, transaction costs would be greatly reduced, as compared with actually purchasing the assets. In terms of developing a predictive hedge, however, transaction costs could well become a limiting factor to the number of securities held, as well as the frequency of rebalancing and/or reconfiguring the hedge portfolio. Transaction costs would certainly become part of the equation.

In terms of actually implementing the dynamic hedging methodology, another practical problem arises due to the inherent lag that exists between the end of a reporting period and the time the data becomes available. For the purpose of this research, we assumed that there was no reporting lag and utilized the data as if it were contemporaneously available. Assuming a thirty day lag the effect of this problem would be to limit the hedger's ability to utilize the previous month's return data in developing the static replicating hedge. Given that the predictive ability of the hedge appears to be somewhat limited in the short term, perhaps this is not a very limiting factor, since investors would need a longer time frame than one month to achieve an accurate hedge.

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CBOE REIT Index Options
Symbol: RIX

Index composition:

American Health Properties Inc.
Avalon Properties Inc.
CBL and Associates Properties Inc.
Duke Realty Investments Inc.
Debartolo Realty Corp.
Equity Residential Properties Trust
Federal Realty Investment Trust
General Growth Properties Inc.
Glimcher Trust
Health Care Property Investors Inc.
HGI Realty, Inc.
Kimco Realty Corp.
Manufactured Home Communities
Merry Land & Investment Co.
Nationwide Health Properties Inc.
New Plan Realty Trust
Post Properties Inc.
Public Storage
Security Capital Pacific Trust
Simon Property Group Inc.
Spieker Properties Inc.
Taubman Centers Inc.
United Dominion Realty Trust Inc.
Washington Real Estate Investment Trust
Weingarten Realty Investors

Monthly Trading Volume (1995)
Number of Contracts

February	3,650
March	40
April	4,838
May	1,742
June	1,018
July	2,224
August	105
September	553
October	186
November	345
December	488

Appendix I

CBOE REIT Index Options

Industrial Sector
Reported Returns

Sample: 1987:01 1996:04
Included observations: 112

<table>
<tr><th>Autocorrelation</th><th>Partial Autocorrelation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>. |*******|</td><td>. |*******|</td><td>1</td><td>0.896</td><td>0.896</td><td>92.287</td><td>0</td></tr>
<tr><td>. |****** |</td><td>. |** |</td><td>2</td><td>0.843</td><td>0.206</td><td>174.77</td><td>0</td></tr>
<tr><td>. |****** |</td><td>. |* |</td><td>3</td><td>0.799</td><td>0.082</td><td>249.64</td><td>0</td></tr>
<tr><td>. |****** |</td><td>.*|. |</td><td>4</td><td>0.721</td><td>-0.168</td><td>311.15</td><td>0</td></tr>
<tr><td>. |***** |</td><td>.*|. |</td><td>5</td><td>0.634</td><td>-0.174</td><td>359.08</td><td>0</td></tr>
<tr><td>. |**** |</td><td>. |. |</td><td>6</td><td>0.569</td><td>0.004</td><td>398.14</td><td>0</td></tr>
<tr><td>. |**** |</td><td>. |. |</td><td>7</td><td>0.495</td><td>-0.033</td><td>427.91</td><td>0</td></tr>
<tr><td>. |*** |</td><td>. |. |</td><td>8</td><td>0.422</td><td>-0.01</td><td>449.77</td><td>0</td></tr>
<tr><td>. |*** |</td><td>.*|. |</td><td>9</td><td>0.35</td><td>-0.059</td><td>464.97</td><td>0</td></tr>
<tr><td>. |** |</td><td>. |* |</td><td>10</td><td>0.309</td><td>0.107</td><td>476.9</td><td>0</td></tr>
<tr><td>. |** |</td><td>.*|. |</td><td>11</td><td>0.237</td><td>-0.118</td><td>484</td><td>0</td></tr>
<tr><td>. |* |</td><td>.*|. |</td><td>12</td><td>0.165</td><td>-0.114</td><td>487.47</td><td>0</td></tr>
<tr><td>. |* |</td><td>. |. |</td><td>13</td><td>0.116</td><td>-0.006</td><td>489.21</td><td>0</td></tr>
<tr><td>. |* |</td><td>. |. |</td><td>14</td><td>0.066</td><td>0.005</td><td>489.78</td><td>0</td></tr>
</table>

Industrial Sector
1 & 3 Month Lagged Returns

Sample: 1987:04 1996:04
Included observations: 109

<table>
<tr><th>Autocorrelation</th><th>Partial Autocorrelation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>. |. |</td><td>. |. |</td><td>1</td><td>-0.054</td><td>-0.054</td><td>0.3316</td><td>0.565</td></tr>
<tr><td>. |* |</td><td>. |* |</td><td>2</td><td>0.136</td><td>0.133</td><td>2.4175</td><td>0.299</td></tr>
<tr><td>. |* |</td><td>. |* |</td><td>3</td><td>0.148</td><td>0.165</td><td>4.9013</td><td>0.179</td></tr>
<tr><td>. |* |</td><td>. |* |</td><td>4</td><td>0.075</td><td>0.079</td><td>5.5483</td><td>0.236</td></tr>
<tr><td>. |. |</td><td>.*|. |</td><td>5</td><td>-0.044</td><td>-0.08</td><td>5.7733</td><td>0.329</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>6</td><td>0.048</td><td>-0.008</td><td>6.0401</td><td>0.419</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>7</td><td>-0.025</td><td>-0.031</td><td>6.1135</td><td>0.527</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>8</td><td>0.03</td><td>0.037</td><td>6.2235</td><td>0.622</td></tr>
<tr><td>.*|. |</td><td>.*|. |</td><td>9</td><td>-0.132</td><td>-0.125</td><td>8.3315</td><td>0.501</td></tr>
<tr><td>. |* |</td><td>. |* |</td><td>10</td><td>0.108</td><td>0.09</td><td>9.7601</td><td>0.462</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>11</td><td>-0.011</td><td>0.036</td><td>9.7761</td><td>0.551</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>12</td><td>-0.05</td><td>-0.043</td><td>10.087</td><td>0.608</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>13</td><td>-0.031</td><td>-0.056</td><td>10.204</td><td>0.677</td></tr>
<tr><td>. |* |</td><td>. |* |</td><td>14</td><td>0.179</td><td>0.169</td><td>14.301</td><td>0.428</td></tr>
</table>

Office Sector
Reported Returns

Sample: 1987:01 1996:04
Included observations: 112

<table>
<tr><th>Autocorrelation</th><th>Partial Autocorrelation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>. |*******|</td><td>. |*******|</td><td>1</td><td>0.871</td><td>0.871</td><td>87.319</td><td>0</td></tr>
<tr><td>. |****** |</td><td>. |*** |</td><td>2</td><td>0.842</td><td>0.346</td><td>169.7</td><td>0</td></tr>
<tr><td>. |****** |</td><td>. |** |</td><td>3</td><td>0.836</td><td>0.257</td><td>251.56</td><td>0</td></tr>
<tr><td>. |****** |</td><td>.*|. |</td><td>4</td><td>0.782</td><td>-0.061</td><td>323.83</td><td>0</td></tr>
<tr><td>. |****** |</td><td>.*|. |</td><td>5</td><td>0.728</td><td>-0.129</td><td>387.02</td><td>0</td></tr>
<tr><td>. |***** |</td><td>.*|. |</td><td>6</td><td>0.675</td><td>-0.141</td><td>441.91</td><td>0</td></tr>
<tr><td>. |***** |</td><td>.*|. |</td><td>7</td><td>0.618</td><td>-0.101</td><td>488.33</td><td>0</td></tr>
<tr><td>. |**** |</td><td>.*|. |</td><td>8</td><td>0.558</td><td>-0.071</td><td>526.55</td><td>0</td></tr>
<tr><td>. |**** |</td><td>. |. |</td><td>9</td><td>0.503</td><td>-0.018</td><td>557.9</td><td>0</td></tr>
<tr><td>. |*** |</td><td>.*|. |</td><td>10</td><td>0.434</td><td>-0.079</td><td>581.43</td><td>0</td></tr>
<tr><td>. |*** |</td><td>. |. |</td><td>11</td><td>0.39</td><td>0.049</td><td>600.61</td><td>0</td></tr>
<tr><td>. |** |</td><td>. |. |</td><td>12</td><td>0.327</td><td>-0.047</td><td>614.24</td><td>0</td></tr>
<tr><td>. |** |</td><td>. |. |</td><td>13</td><td>0.275</td><td>0.015</td><td>624.03</td><td>0</td></tr>
<tr><td>. |** |</td><td>. |. |</td><td>14</td><td>0.226</td><td>-0.023</td><td>630.68</td><td>0</td></tr>
</table>

Office Sector
1 & 3 Month Lagged Returns

Sample: 1987:04 1996:04
Included observations: 109

<table>
<tr><th>Autocorrelation</th><th>Partial Autocorrelation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>.*|. |</td><td>.*|. |</td><td>1</td><td>-0.089</td><td>-0.089</td><td>0.8805</td><td>0.348</td></tr>
<tr><td>. |** |</td><td>. |** |</td><td>2</td><td>0.207</td><td>0.2</td><td>5.7058</td><td>0.058</td></tr>
<tr><td>. |* |</td><td>. |* |</td><td>3</td><td>0.066</td><td>0.104</td><td>6.2067</td><td>0.102</td></tr>
<tr><td>. |* |</td><td>. |* |</td><td>4</td><td>0.121</td><td>0.099</td><td>7.901</td><td>0.095</td></tr>
<tr><td>. |* |</td><td>. |. |</td><td>5</td><td>0.075</td><td>0.064</td><td>8.5472</td><td>0.129</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>6</td><td>0.053</td><td>0.018</td><td>8.8817</td><td>0.18</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>7</td><td>0.058</td><td>0.022</td><td>9.2844</td><td>0.233</td></tr>
<tr><td>. |. |</td><td>.*|. |</td><td>8</td><td>-0.028</td><td>-0.062</td><td>9.3803</td><td>0.311</td></tr>
<tr><td>. |* |</td><td>. |. |</td><td>9</td><td>0.068</td><td>0.024</td><td>9.9373</td><td>0.356</td></tr>
<tr><td>.*|. |</td><td>.*|. |</td><td>10</td><td>-0.098</td><td>-0.099</td><td>11.109</td><td>0.349</td></tr>
<tr><td>. |* |</td><td>. |. |</td><td>11</td><td>0.08</td><td>0.04</td><td>11.907</td><td>0.371</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>12</td><td>-0.055</td><td>-0.015</td><td>12.287</td><td>0.423</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>13</td><td>-0.001</td><td>-0.021</td><td>12.287</td><td>0.504</td></tr>
<tr><td>. |. |</td><td>. |* |</td><td>14</td><td>0.043</td><td>0.067</td><td>12.525</td><td>0.564</td></tr>
</table>

Appendix II

Correlogram Results

Retail Sector
Reported Returns

Sample: 1987:01 1996:04
Included observations: 112

<table>
<tr><th>Autocorrelation</th><th>Partial Autocorrelation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>. |*******|</td><td>. |*******|</td><td>1</td><td>0.872</td><td>0.872</td><td>87.431</td><td>0</td></tr>
<tr><td>. |****** |</td><td>. |* |</td><td>2</td><td>0.799</td><td>0.163</td><td>161.58</td><td>0</td></tr>
<tr><td>. |****** |</td><td>. |* |</td><td>3</td><td>0.771</td><td>0.194</td><td>231.18</td><td>0</td></tr>
<tr><td>. |***** |</td><td>.*|. |</td><td>4</td><td>0.692</td><td>-0.143</td><td>287.85</td><td>0</td></tr>
<tr><td>. |***** |</td><td>. |. |</td><td>5</td><td>0.626</td><td>-0.027</td><td>334.58</td><td>0</td></tr>
<tr><td>. |**** |</td><td>.*|. |</td><td>6</td><td>0.539</td><td>-0.183</td><td>369.56</td><td>0</td></tr>
<tr><td>. |*** |</td><td>. |. |</td><td>7</td><td>0.456</td><td>-0.056</td><td>394.85</td><td>0</td></tr>
<tr><td>. |*** |</td><td>.*|. |</td><td>8</td><td>0.378</td><td>-0.082</td><td>412.39</td><td>0</td></tr>
<tr><td>. |** |</td><td>.*|. |</td><td>9</td><td>0.289</td><td>-0.068</td><td>422.75</td><td>0</td></tr>
<tr><td>. |** |</td><td>.*|. |</td><td>10</td><td>0.204</td><td>-0.072</td><td>427.96</td><td>0</td></tr>
<tr><td>. |* |</td><td>. |. |</td><td>11</td><td>0.135</td><td>0.012</td><td>430.27</td><td>0</td></tr>
<tr><td>. |* |</td><td>. |. |</td><td>12</td><td>0.075</td><td>0.021</td><td>431</td><td>0</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>13</td><td>0.008</td><td>-0.036</td><td>431.01</td><td>0</td></tr>
<tr><td>.*|. |</td><td>.*|. |</td><td>14</td><td>-0.06</td><td>-0.066</td><td>431.48</td><td>0</td></tr>
</table>

Retail Sector
1 & 3 Month Lagged Returns

Sample: 1987:04 1996:04
Included observations: 109

<table>
<tr><th>Autocorrelation</th><th>Partial Autocorrelation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>. |. |</td><td>. |. |</td><td>1</td><td>0.019</td><td>0.019</td><td>0.0396</td><td>0.842</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>2</td><td>0.046</td><td>0.046</td><td>0.2831</td><td>0.868</td></tr>
<tr><td>. |* |</td><td>. |* |</td><td>3</td><td>0.159</td><td>0.158</td><td>3.1807</td><td>0.365</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>4</td><td>-0.008</td><td>-0.015</td><td>3.1876</td><td>0.527</td></tr>
<tr><td>. |* |</td><td>. |* |</td><td>5</td><td>0.133</td><td>0.122</td><td>5.2382</td><td>0.388</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>6</td><td>0.006</td><td>-0.023</td><td>5.2425</td><td>0.513</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>7</td><td>0.005</td><td>0</td><td>5.2453</td><td>0.63</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>8</td><td>0.04</td><td>0.001</td><td>5.4412</td><td>0.71</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>9</td><td>-0.042</td><td>-0.039</td><td>5.6525</td><td>0.774</td></tr>
<tr><td>. |. |</td><td>.*|. |</td><td>10</td><td>-0.057</td><td>-0.077</td><td>6.0505</td><td>0.811</td></tr>
<tr><td>. |. |</td><td>.*|. |</td><td>11</td><td>-0.057</td><td>-0.06</td><td>6.4509</td><td>0.842</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>12</td><td>0.02</td><td>0.04</td><td>6.5024</td><td>0.889</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>13</td><td>-0.046</td><td>-0.031</td><td>6.7641</td><td>0.914</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>14</td><td>-0.021</td><td>0.007</td><td>6.8191</td><td>0.941</td></tr>
</table>

All Property Sector
Reported Returns

Sample: 1987:01 1996:04
Included observations: 112

<table>
<tr><th>Autocorrelation</th><th>Partial Autocorrelation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>. |*******|</td><td>. |*******|</td><td>1</td><td>0.902</td><td>0.902</td><td>93.53</td><td>0</td></tr>
<tr><td>. |*******|</td><td>. |** |</td><td>2</td><td>0.865</td><td>0.28</td><td>180.45</td><td>0</td></tr>
<tr><td>. |****** |</td><td>. |* |</td><td>3</td><td>0.835</td><td>0.12</td><td>262.12</td><td>0</td></tr>
<tr><td>. |****** |</td><td>**|. |</td><td>4</td><td>0.761</td><td>-0.215</td><td>330.53</td><td>0</td></tr>
<tr><td>. |***** |</td><td>.*|. |</td><td>5</td><td>0.694</td><td>-0.147</td><td>387.94</td><td>0</td></tr>
<tr><td>. |***** |</td><td>.*|. |</td><td>6</td><td>0.624</td><td>-0.112</td><td>434.85</td><td>0</td></tr>
<tr><td>. |**** |</td><td>. |. |</td><td>7</td><td>0.556</td><td>-0.011</td><td>472.42</td><td>0</td></tr>
<tr><td>. |**** |</td><td>. |. |</td><td>8</td><td>0.48</td><td>-0.054</td><td>500.74</td><td>0</td></tr>
<tr><td>. |*** |</td><td>. |. |</td><td>9</td><td>0.407</td><td>-0.042</td><td>521.27</td><td>0</td></tr>
<tr><td>. |*** |</td><td>. |. |</td><td>10</td><td>0.337</td><td>-0.041</td><td>535.46</td><td>0</td></tr>
<tr><td>. |** |</td><td>. |. |</td><td>11</td><td>0.267</td><td>-0.023</td><td>544.49</td><td>0</td></tr>
<tr><td>. |* |</td><td>.*|. |</td><td>12</td><td>0.194</td><td>-0.067</td><td>549.3</td><td>0</td></tr>
<tr><td>. |* |</td><td>. |. |</td><td>13</td><td>0.14</td><td>0.042</td><td>551.82</td><td>0</td></tr>
<tr><td>. |* |</td><td>. |. |</td><td>14</td><td>0.09</td><td>0.041</td><td>552.87</td><td>0</td></tr>
</table>

All Property Sector
1 & 3 Month Lagged Returns

Sample: 1987:04 1996:04
Included observations: 109

<table>
<tr><th>Autocorrelation</th><th>Partial Autocorrelation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>.*|. |</td><td>.*|. |</td><td>1</td><td>-0.066</td><td>-0.066</td><td>0.4874</td><td>0.485</td></tr>
<tr><td>. |* |</td><td>. |* |</td><td>2</td><td>0.192</td><td>0.189</td><td>4.6743</td><td>0.097</td></tr>
<tr><td>. |* |</td><td>. |** |</td><td>3</td><td>0.192</td><td>0.224</td><td>8.878</td><td>0.031</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>4</td><td>0.04</td><td>0.038</td><td>9.0623</td><td>0.06</td></tr>
<tr><td>. |* |</td><td>. |. |</td><td>5</td><td>0.07</td><td>-0.005</td><td>9.6251</td><td>0.087</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>6</td><td>0.019</td><td>-0.036</td><td>9.6683</td><td>0.139</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>7</td><td>0.046</td><td>0.017</td><td>9.9179</td><td>0.193</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>8</td><td>-0.004</td><td>-0.013</td><td>9.9203</td><td>0.271</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>9</td><td>0.005</td><td>-0.01</td><td>9.9237</td><td>0.357</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>10</td><td>-0.029</td><td>-0.042</td><td>10.024</td><td>0.438</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>11</td><td>-0.001</td><td>-0.005</td><td>10.024</td><td>0.528</td></tr>
<tr><td>.*|. |</td><td>.*|. |</td><td>12</td><td>-0.083</td><td>-0.076</td><td>10.882</td><td>0.539</td></tr>
<tr><td>. |. |</td><td>.*|. |</td><td>13</td><td>-0.053</td><td>-0.057</td><td>11.241</td><td>0.591</td></tr>
<tr><td>. |* |</td><td>. |* |</td><td>14</td><td>0.091</td><td>0.126</td><td>12.297</td><td>0.582</td></tr>
</table>

Appendix II

Correlogram Results

Industry Sector

LS // Dependent Variable is IND
Sample(adjusted): 1987:04 1996:04
Included observations: 109 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
IND(-1)	0.767849	0.078674	9.759838	0
IND(-3)	0.154619	0.078769	1.962951	0.0523
C	0.000194	0.000526	0.368514	0.7132

R-squared	0.812081	Mean dependent var	0.003316
Adjusted R-squared	0.808535	S.D. dependent var	0.012038
S.E. of regression	0.005268	Akaike info criterion	-10.46521
Sum squared resid	0.002941	Schwarz criterion	-10.39114
Log likelihood	418.6899	F-statistic	229.0359
Durbin-Watson stat	2.10769	Prob(F-statistic)	0

Office Sector

LS // Dependent Variable is OFF
Sample(adjusted): 1987:04 1996:04
Included observations: 109 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
OFF(-1)	0.580178	0.081333	7.133325	0
OFF(-3)	0.347307	0.081249	4.274586	0
C	5.59E-06	0.000576	0.009697	0.9923

R-squared	0.797747	Mean dependent var	0.000576
Adjusted R-squared	0.793931	S.D. dependent var	0.013236
S.E. of regression	0.006008	Akaike info criterion	-10.20206
Sum squared resid	0.003827	Schwarz criterion	-10.12798
Log likelihood	404.3478	F-statistic	209.0486
Durbin-Watson stat	2.176902	Prob(F-statistic)	0

Retail Sector

LS // Dependent Variable is RE
Sample(adjusted): 1987:04 1996:04
Included observations: 109 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RE(-1)	0.707047	0.076343	9.261423	0
RE(-3)	0.207307	0.076415	2.712916	0.0078
C	0.000106	0.000426	0.249994	0.8031

R-squared	0.777237	Mean dependent var	0.002055
Adjusted R-squared	0.773034	S.D. dependent var	0.009046
S.E. of regression	0.004309	Akaike info criterion	-10.86679
Sum squared resid	0.001968	Schwarz criterion	-10.79272
Log likelihood	440.5759	F-statistic	184.921
Durbin-Watson stat	1.960742	Prob(F-statistic)	0

All Property Sector

LS // Dependent Variable is ALL
Sample(adjusted): 1987:04 1996:04
Included observations: 109 after adjusting endpoints

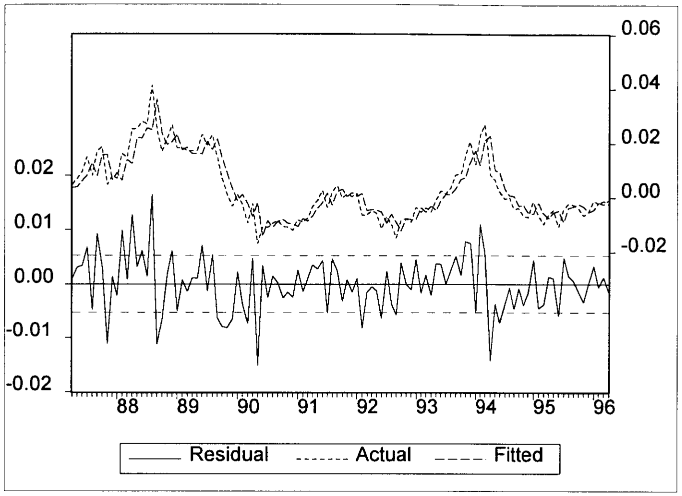
Variable	Coefficient	Std. Error	t-Statistic	Prob.
ALL(-1)	0.712898	0.080998	8.801412	0
ALL(-3)	0.219034	0.08103	2.703134	0.008
C	6.44E-05	0.000436	0.147885	0.8827

R-squared	0.826155	Mean dependent var	0.001734
Adjusted R-squared	0.822875	S.D. dependent var	0.010638
S.E. of regression	0.004477	Akaike info criterion	-10.79036
Sum squared resid	0.002125	Schwarz criterion	-10.71629
Log likelihood	436.4104	F-statistic	251.8698
Durbin-Watson stat	2.131201	Prob(F-statistic)	0

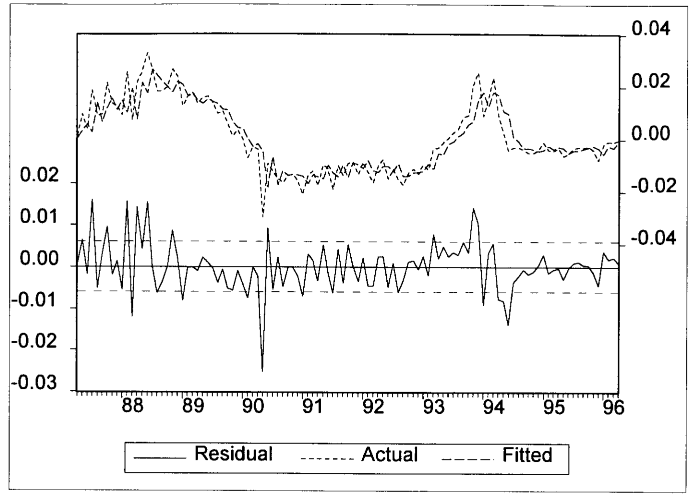
Appendix III

Regression Results for 1 and 3 Month Lags

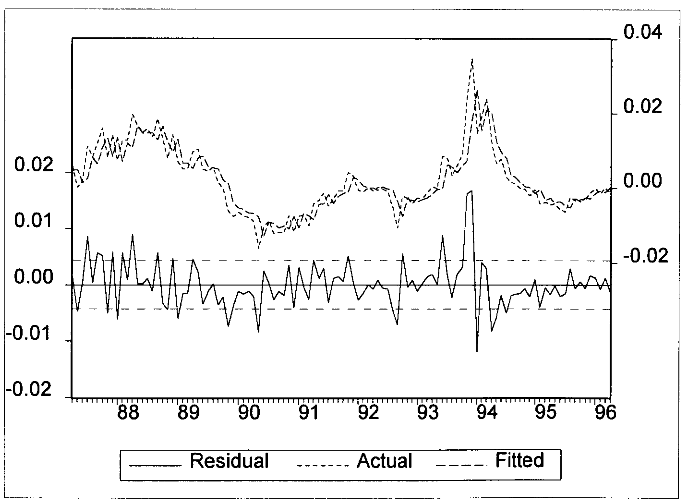
Industrial Sector



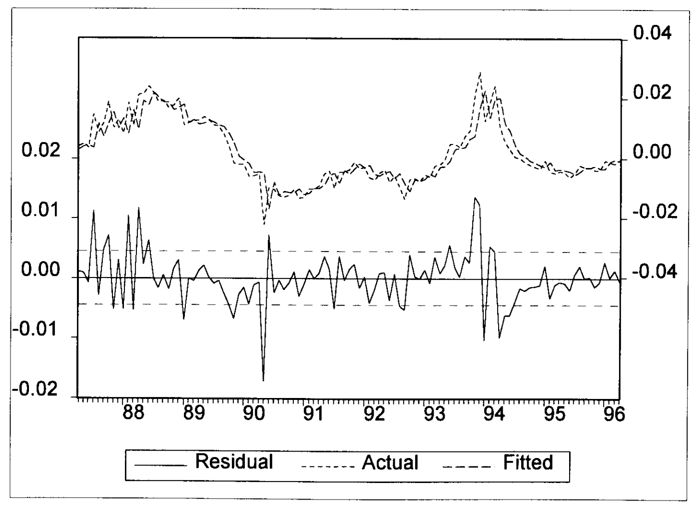
Office Sector



Retail Sector



All Property Sector



Appendix IV

Actual Returns vs. Fitted Returns

Calculation of w(o):

w(0)=[SSE/(n-2)]^.5/[a*(st dev FTSE)]

where:		
a =	0.6000	
st dev FTSE=	0.2000	annually
	0.0577	monthly

	w(o)	1-month coefficient	3-month coefficient
Industrial	0.1513	0.7678	0.1546
Office	0.0577	0.5802	0.3473
Retail	0.1238	0.7070	0.2073
All Property	0.1286	0.7129	0.2190

Calculated underlying return for two period lag:

r(t)=[1/w(0)]*[r(t)*-Beta1*r(t-1)*-Beta2*r(t-3)*]]

Monthly Returns

		Reported Industrial	Unsmoothed Industrial r(t)	Reported Office	Unsmoothed Office r(t)	Reported Retail	Unsmoothed Retail r(t)	Reported All	Unsmoothed All Property r(t)
1987	Jan	0.1673		0.0338		0.2433		0.1458	
	Feb	-0.0162		0.7220		0.2686		0.4233	
	Mar	0.4319		0.0532		0.5682		0.3430	
	Apr	0.4842	0.8371	0.1246	0.4753	0.5901	1.1140	0.3929	0.9053
	May	0.6972	2.1668	0.9644	3.7150	0.0089	-3.7478	0.4694	0.7508
	Jun	0.9608	2.3700	0.3884	-1.0984	0.1697	0.3683	0.3369	-0.5670
	Jul	1.5072	4.5892	1.8661	9.2530	1.1175	7.0690	1.4540	8.7670
	Aug	0.8149	-2.9748	0.9004	-2.9960	0.8339	0.3393	0.8590	-2.1792
	Sep	1.7173	6.2311	0.9479	1.6837	1.2067	4.7002	1.1541	3.6369
	Oct	1.8787	2.1608	2.1546	5.5405	1.6062	4.2111	1.8656	5.6315
	Nov	0.4797	-7.1943	1.3653	-1.1438	0.8130	-4.0024	1.0043	-3.9945
	Dec	0.7949	1.0636	1.2582	0.7925	1.4201	4.8068	1.2841	2.4513
1988	Jan	0.7048	-1.2954	0.9274	-3.1909	0.7290	-4.9114	0.8105	-3.9925
	Feb	1.6255	6.6749	2.5793	9.0771	1.2665	4.7050	1.8454	8.1439
	Mar	1.4688	0.6456	0.7345	-6.9444	1.2818	0.7424	1.0711	-4.0870
	Apr	2.5336	8.5687	2.1814	8.3010	1.9643	7.3250	2.1176	9.1458
	May	2.5311	2.2093	2.5842	2.4489	1.6781	0.2158	2.1477	1.8179
	Jun	2.8004	4.1611	3.2981	8.9418	1.4850	0.2649	2.4017	4.9436
	Jul	2.7019	1.0567	2.6780	0.0403	1.5792	0.9856	2.1753	-0.0056
	Aug	4.1277	10.9795	1.8209	-3.6509	1.3611	-0.8349	1.8628	-1.2313
	Sep	2.4960	-7.3107	1.8384	-2.1054	1.8548	4.7220	1.9189	0.5044
	Oct	1.7002	-4.1899	2.0070	0.0592	1.3224	-2.5556	1.6669	-1.3798
	Nov	2.1528	1.3812	2.6671	5.0411	0.7869	-3.4757	1.7611	1.2805
	Dec	2.6744	4.1991	2.3832	1.1427	1.4259	3.9175	1.9874	2.4227
1989	Jan	1.8313	-3.2054	1.2672	-4.7064	0.6840	-4.8324	1.0894	-5.3838
	Feb	1.8344	0.6300	1.6343	-0.1577	0.5044	-1.1502	1.1715	0.0709
	Mar	1.7043	-0.7784	1.7645	-0.0662	0.5130	-1.1246	1.2296	-0.3175
	Apr	1.7265	0.8900	1.3639	-0.5785	0.9700	3.7602	1.2471	1.0254
	May	1.7314	0.8070	1.5836	1.3014	1.0301	1.9356	1.3684	1.7315
	Jun	2.3245	4.8333	1.6418	0.6387	0.4987	-2.7137	1.2697	0.1931
	Jul	1.9385	-0.7485	1.3868	-0.2284	0.4405	-0.9140	1.0956	-0.6435
	Aug	2.3082	3.6471	0.9736	-2.2072	0.5509	0.2090	1.0465	-0.2659
	Sep	1.5225	-4.0258	1.0693	-0.3811	0.1440	-2.8182	0.7843	-1.8645
	Oct	0.7008	-5.0739	0.5862	-2.9880	-0.0181	-1.7059	0.3641	-3.3813
	Nov	0.1119	-5.1742	0.1149	-3.2626	-0.6277	-5.8893	-0.1817	-5.2119
	Dec	-0.3076	-4.1556	0.3485	-0.5187	-0.7683	-2.8620	-0.2282	-2.1025
1990	Jan	0.1168	1.6164	0.0076	-2.3064	-0.6550	-0.8725	-0.2266	-1.1173
	Feb	-0.2390	-2.2866	-0.7097	-4.3673	-0.7553	-1.3091	-0.6338	-3.3617
	Mar	-0.9396	-4.6810	-0.2935	-0.0159	-0.7963	-0.8319	-0.6101	-0.8413
	Apr	-0.2073	3.2776	-0.3902	-1.2892	-0.8995	-1.6216	-0.5433	-0.4571
	May	-1.6878	-9.8562	-2.9955	-14.6122	-1.6263	-6.7345	-2.2374	-13.3023
	Jun	-1.0785	2.3969	-0.9177	5.3414	-1.0559	2.0930	-1.0028	5.6427

Monthly Indices

		Reported Industrial	Unsmoothed Industrial	Reported Office	Unsmoothed Office	Reported Retail	Unsmoothed Retail	Reported All	Unsmoothed All
1987	Jan	100.1673	100.0000	100.0338	100.0000	100.2433	100.0000	100.1458	100.0000
	Feb	100.1511	100.0000	100.7560	100.0000	100.5126	100.0000	100.5697	100.0000
	Mar	100.5836	100.0000	100.8096	100.0000	101.0837	100.0000	100.9147	100.0000
	Apr	101.0706	100.8371	100.9352	100.4753	101.6801	101.1140	101.3112	100.9053
	May	101.7753	103.0220	101.9087	104.2080	101.6892	97.3244	101.7868	101.6629
	Jun	102.7532	105.4636	102.3045	103.0634	101.8617	97.6828	102.1297	101.0865
	Jul	104.3019	110.3036	104.2135	112.5999	103.0000	104.5880	103.6147	109.9487
	Aug	105.1518	107.0223	105.1518	109.2264	103.8589	104.9429	104.5047	107.5527
	Sep	106.9576	113.6909	106.1486	111.0654	105.1122	109.8753	105.7108	111.4643
	Oct	108.9669	116.1475	108.4357	117.2189	106.8005	114.5022	107.6830	117.7414
	Nov	109.4897	107.7915	109.9162	115.8782	107.6688	109.9195	108.7644	113.0382
	Dec	110.3600	108.9380	111.2991	116.7965	109.1978	115.2030	110.1611	115.8092
1988	Jan	111.1377	107.5268	112.3312	113.0697	109.9939	109.5450	111.0539	111.1854
	Feb	112.9443	114.7041	115.2286	123.3332	111.3869	114.6990	113.1033	120.2403
	Mar	114.6032	115.4446	116.0750	114.7684	112.8146	115.5506	114.3147	115.3261
	Apr	117.5067	125.3367	118.6070	124.2954	115.0306	124.0147	116.7355	125.8736
	May	120.4810	128.1057	121.6720	127.3393	116.9609	124.2823	119.2426	128.1619
	Jun	123.8549	133.4363	125.6849	138.7257	118.6978	124.6115	122.1064	134.4977
	Jul	127.2013	134.8464	129.0508	138.7815	120.5723	125.8397	124.7625	134.4902
	Aug	132.4518	149.6519	131.4007	133.7147	122.2134	124.7891	127.0865	132.8342
	Sep	135.7578	138.7112	133.8164	130.8995	124.4802	130.6817	129.5252	133.5042
	Oct	138.0660	132.8994	136.5021	130.9770	126.1263	127.3420	131.6843	131.6622
	Nov	141.0382	134.7350	140.1427	137.5797	127.1188	122.9159	134.0034	133.3482
	Dec	144.8102	140.3927	143.4826	139.1518	128.9313	127.7312	136.6666	136.5788
1989	Jan	147.4622	135.8926	145.3008	132.6028	129.8133	121.5587	138.1554	129.2257
	Feb	150.1672	136.7487	147.6754	132.3937	130.4680	120.1606	139.7739	129.3174
	Mar	152.7265	135.6842	150.2811	132.3061	131.1373	118.8093	141.4926	128.9068
	Apr	155.3632	136.8919	152.3308	131.5408	132.4094	123.2768	143.2572	130.2286
	May	158.0533	137.9966	154.7431	133.2526	133.7733	125.6630	145.2175	132.4836
	Jun	161.7272	144.6665	157.2837	134.1037	134.4404	122.2528	147.0613	132.7395
	Jul	164.8623	143.5836	159.4650	133.7974	135.0326	121.1355	148.6725	131.8852
	Aug	168.6676	148.8203	161.0174	130.8443	135.7765	121.3886	150.2284	131.5346
	Sep	171.2355	142.8290	162.7391	130.3456	135.9720	117.9677	151.4067	129.0821
	Oct	172.4356	135.5820	163.6930	126.4509	135.9475	115.9553	151.9580	124.7174
	Nov	172.6286	128.5667	163.8811	122.3253	135.0941	109.1263	151.6820	118.2172
	Dec	172.0976	123.2240	164.4522	121.6907	134.0563	106.0032	151.3359	115.7317
1990	Jan	172.2987	125.2158	164.4647	118.8841	133.1782	105.0783	150.9929	114.4387
	Feb	171.8868	122.3527	163.2976	113.6921	132.1724	103.7028	150.0359	110.5916
	Mar	170.2719	116.6253	162.8184	113.6740	131.1199	102.8400	149.1206	109.6611
	Apr	169.9189	120.4478	162.1831	112.2085	129.9404	101.1724	148.3104	109.1599
	May	167.0509	108.5761	157.3248	95.8124	127.8272	94.3590	144.9921	94.6391
	Jun	165.2492	111.1786	155.8811	100.9301	126.4775	96.3339	143.5381	99.9793

Appendix V

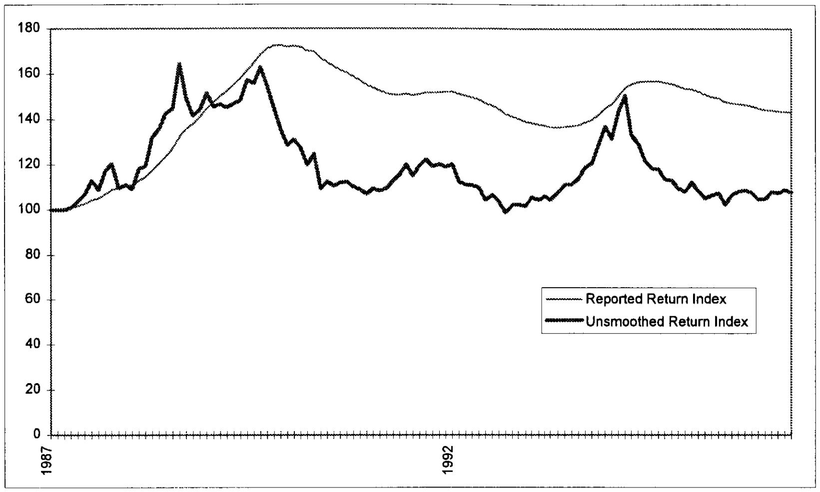
Calculation of Unsmoothed Returns and Indices

		Reported Industrial	Unsmoothed Industrial r(t)	Reported Office	Unsmoothed Office r(t)	Reported Retail	Unsmoothed Retail r(t)	Reported All	Unsmoothed All Property r(t)	Reported Industrial	Unsmoothed Industrial	Reported Office	Unsmoothed Office	Reported Retail	Unsmoothed Retail	Reported All	Unsmoothed All
	Jul	-1.0904	-1.5208	-1.2133	-3.1588	-0.8923	0.3288	-1.0723	-1.8532	163.4474	109.4878	153.9898	97.7419	125.3489	96.6507	141.9990	98.1265
	Aug	-0.9340	1.0849	-1.5090	1.3628	-1.2231	-2.0598	-1.2858	-0.2432	161.9208	110.6757	151.6660	99.0739	123.8158	94.6598	140.1732	97.8879
	Sep	-0.8416	0.2797	-1.6698	-2.7549	-1.1881	-0.8438	-1.3204	-1.4311	160.5581	110.9853	149.1335	96.3446	122.3447	93.8611	138.3224	96.4870
1990	Oct	-1.0503	-1.5557	-1.3923	-0.0123	-1.2099	-1.4935	-1.2542	-0.6070	158.8718	109.2587	147.0571	96.3328	120.8644	92.4592	136.5875	95.9013
	Nov	-1.0829	-0.8723	-1.3492	-0.1004	-0.7456	2.9353	-1.0672	0.8444	157.1514	108.3056	145.0730	96.2360	119.9632	95.1732	135.1299	96.7111
	Dec	-1.1887	-1.5007	-1.5860	-1.2935	-1.1745	-3.2386	-1.3491	-2.3249	155.2833	106.6803	142.7721	94.9913	118.5543	92.0909	133.3069	94.4627
1991	Jan	-0.7968	1.8392	-2.1056	-4.0653	-0.7573	2.6162	-1.3367	-0.7795	154.0460	108.6423	139.7659	91.1296	117.6565	94.5002	131.5250	93.7264
	Feb	-0.8981	-0.7850	-1.3836	1.7760	-0.7314	-0.3339	-1.0382	1.1543	152.6625	107.7894	137.8321	92.7480	116.7960	94.1847	130.1595	94.8083
	Mar	-0.7477	0.8308	-1.2039	0.8668	-1.0094	-2.0097	-1.0348	0.0068	151.5212	108.6849	136.1727	93.5519	115.6170	92.2918	128.8126	94.8147
	Apr	-0.3228	2.4743	-1.7676	-1.9570	-0.4218	3.6259	-0.9421	0.6867	151.0320	111.3741	133.7657	91.7211	115.1293	95.6382	127.5991	95.4658
	May	-0.0860	1.9872	-0.9749	3.0770	-0.3290	0.9764	-0.5308	2.8627	150.9021	113.5873	132.4616	94.5434	114.7506	96.5721	126.9218	98.1988
	Jun	0.2718	2.9961	-1.1342	-0.8715	-0.1390	2.4463	-0.4377	1.3006	151.3123	116.9905	130.9593	93.7195	114.5911	98.9345	126.3663	99.4759
	Jul	-0.3542	-3.3894	-1.9025	-3.6523	-0.4956	-2.5028	-1.0217	-3.9126	150.7764	113.0252	128.4678	90.2966	114.0232	96.4584	125.0751	95.5838
	Aug	0.1991	3.2000	-1.0133	2.4853	-0.2914	1.0274	-0.4687	2.9225	151.0766	116.6421	127.1661	92.5408	113.6910	97.4493	124.4889	98.3773
	Sep	0.4628	1.7704	-1.3747	-2.2757	-0.0805	1.2470	-0.4612	-0.2423	151.7758	118.7072	125.4180	90.4348	113.5995	98.6645	123.9148	98.1389
	Oct	0.0053	-1.9511	-0.9243	3.0930	-0.0892	0.5692	-0.3897	1.2661	151.7839	116.3911	124.2588	93.2319	113.4982	99.2261	123.4319	99.3814
	Nov	0.1355	0.6646	-0.8610	0.1576	0.4066	4.2816	-0.1429	1.8472	151.9895	117.1647	123.1889	93.3788	113.9597	103.4746	123.2556	101.2171
	Dec	0.0487	-0.8386	-1.3335	-2.0653	0.3064	0.2875	-0.3599	-1.2211	152.0635	116.1821	121.5462	91.4502	114.3089	103.7720	122.8119	99.9812
1992	Jan	0.1605	0.8084	-0.8743	1.2766	-0.0627	-2.1068	-0.3113	0.2383	152.3076	117.1214	120.4835	92.6177	114.2372	101.5857	122.4296	100.2195
	Feb	-0.6422	-5.1964	-1.2642	-2.6523	-0.1061	-1.1801	-0.6598	-3.1609	151.3295	111.0353	118.9604	90.1612	114.1160	100.3869	121.6218	97.0517
	Mar	-0.6144	-0.8512	-1.6538	-2.6486	0.0034	0.1208	-0.7441	-1.5152	150.3997	110.0902	116.9930	87.7732	114.1199	100.5081	120.7168	95.5812
	Apr	-0.4756	-0.1895	-1.0135	1.4464	-0.0788	-0.5514	-0.5045	0.7323	149.6843	109.8816	115.8073	89.0428	114.0300	99.9539	120.1078	96.2811
	May	-0.5723	-0.7122	-0.7758	1.4555	0.0186	0.7785	-0.3962	0.8391	148.8276	109.0990	114.9089	90.3388	114.0512	100.7320	119.6319	97.0890
	Jun	-1.1421	-4.0152	-1.5116	-2.8214	-0.0365	-0.4070	-0.8054	-2.7980	147.1278	104.7184	113.1720	87.7900	114.0096	100.3219	118.6684	94.3724
	Jul	-0.6885	1.7314	-1.1377	0.5289	-0.1038	-0.4981	-0.6050	0.6197	146.1149	106.5315	111.8845	88.2543	113.8912	99.8222	117.9505	94.9572
	Aug	-0.9740	-2.3576	-1.5368	-3.5179	-0.5178	-3.6203	-0.9626	-3.4558	144.6918	104.0199	110.1650	85.1496	113.3016	96.2083	116.8151	91.6757
	Sep	-1.4716	-3.6151	-1.7377	-1.8599	-1.0746	-5.6617	-1.3849	-4.0598	142.5625	100.2594	108.2507	83.5659	112.0841	90.7612	115.1973	87.9539
	Oct	-0.8218	2.7394	-1.2896	0.6583	-0.2181	4.5493	-0.7149	3.1475	141.3909	103.0060	106.8547	84.1160	111.8396	94.8902	114.3738	90.7223
	Nov	-0.7633	0.1211	-1.1278	0.8928	-0.2930	-0.2545	-0.6785	0.3268	140.3117	103.1307	105.6495	84.8670	111.5119	94.6487	113.5978	91.0187
	Dec	-0.8949	-0.5368	-1.3196	-0.3576	-0.3355	0.7631	-0.7859	0.0086	139.0561	102.5771	104.2554	84.5635	111.1378	95.3709	112.7050	91.0265
1993	Jan	-0.3381	3.1456	-0.9606	1.4650	-0.3836	-0.8170	-0.5652	1.1788	138.5859	105.8037	103.2539	85.8024	110.7115	94.5918	112.0680	92.0996
	Feb	-0.5279	-0.9930	-1.1596	-1.2200	-0.2989	0.2672	-0.6288	-0.6008	137.8543	104.7531	102.0566	84.7556	110.3806	94.8445	111.3633	91.5462
	Mar	-0.3567	1.2358	-0.3539	4.5018	-0.1264	1.2481	-0.2521	2.8634	137.3625	106.0476	101.6954	88.5711	110.2411	96.0282	111.0825	94.1675
	Apr	-0.5144	-1.2435	-0.3394	1.1560	0.0314	1.6172	-0.2111	0.7186	136.6560	104.7289	101.3503	89.5950	110.2757	97.5812	110.8480	94.8442
	May	-0.0793	2.6254	-0.1184	2.7874	-0.0265	0.1072	-0.0678	1.7136	136.5477	107.4784	101.2303	92.0924	110.2465	97.6858	110.7729	96.4694
	Jun	0.2640	2.5111	0.0518	1.4100	0.8490	7.2207	0.4671	4.4356	136.9082	110.1773	101.2827	93.3909	111.1825	104.7394	111.2903	100.7484
	Jul	0.1441	0.1378	0.2628	2.0305	0.7821	1.4161	0.4817	1.5152	137.1054	110.3291	101.5489	95.2872	112.0520	106.2227	111.8263	102.2750
	Aug	0.3731	1.8150	0.3959	1.6482	0.3244	-1.8021	0.3573	0.2233	137.6169	112.3316	101.9508	96.8577	112.4155	104.3085	112.2258	102.5034
	Sep	0.8573	3.5019	0.8428	3.4469	0.6012	1.5816	0.7317	2.9126	138.7966	116.2654	102.8100	100.1963	113.0913	105.9582	113.0470	105.4889
	Oct	0.8646	1.2162	0.9216	1.9777	0.9076	2.5879	0.9020	2.1367	139.9966	117.6794	103.7576	102.1779	114.1177	108.7003	114.0666	107.7428
	Nov	1.5269	5.3211	2.0855	8.1861	2.3449	13.2142	2.0949	10.6778	142.1342	123.9412	105.9214	110.5423	116.7937	123.0641	116.4562	119.2474
	Dec	2.0779	5.1073	2.5492	6.0620	3.4716	13.6427	2.8979	9.6719	145.0876	130.2713	108.6215	117.2434	120.8483	139.8534	119.8310	130.7809
1994	Jan	1.2343	-3.2704	0.8862	-5.2876	1.4562	-9.5844	1.2327	-8.0129	146.8784	126.0110	109.5842	111.0440	122.6080	126.4493	121.3081	120.3016
	Feb	2.2980	7.3619	1.5770	1.9610	1.9210	3.2741	1.8816	4.2288	150.2536	135.2878	111.3123	113.2216	124.9633	130.5894	123.5906	125.3889
	Mar	2.6930	4.0118	2.3531	3.2019	2.3857	2.4855	2.4358	3.5728	154.2999	140.7153	113.9316	116.8468	127.9445	133.8352	126.6010	129.8687
	Apr	0.8481	-9.3198	0.9034	-4.4577	1.1627	-6.6717	1.0176	-7.6867	155.6086	127.6009	114.9608	111.6381	129.4321	124.9061	127.8893	119.8861
	May	0.6600	-2.2898	0.2549	-4.7319	0.6526	-4.5853	0.5266	-4.7495	156.6356	124.6791	115.2539	106.3555	130.2768	119.1787	128.5628	114.1921
	Jun	0.2275	-4.5969	-0.4281	-8.0701	0.7710	-1.4946	0.2891	-4.8186	156.9918	118.9477	114.7605	97.7725	131.2812	117.3975	128.9344	108.6897
	Jul	-0.0412	-2.2927	-0.3093	-2.1705	0.2867	-4.0343	0.0357	-3.0572	156.9272	116.2206	114.4055	95.6504	131.6575	112.6614	128.9804	105.3668
	Aug	0.0247	-0.3020	-0.3074	-1.2537	0.1522	-1.5009	-0.0165	-1.2228	156.9659	115.8697	114.0538	94.4512	131.8579	110.9704	128.9591	104.0784
	Sep	-0.3919	-2.9473	-0.3975	-0.4082	0.1114	-1.2604	-0.1457	-1.5329	156.3508	112.4547	113.6005	94.0656	132.0047	109.5717	128.7713	102.4829
	Oct	-0.3703	-0.4160	-0.5109	-1.0013	-0.0070	-1.1723	-0.2349	-1.0792	155.7719	111.9868	113.0201	93.1237	131.9955	108.2872	128.4688	101.3769
	Nov	-0.6510	-2.4481	-0.5153	-0.6493	-0.0295	-0.4535	-0.3026	-1.0225	154.7578	109.2453	112.4377	92.5191	131.9566	107.7961	128.0801	100.3404
	Dec	-0.7143	-1.0165	-0.3873	0.2881	-0.2044	-1.6690	-0.3586	-0.8630	153.6524	108.1348	112.0023	92.7857	131.6868	105.9970	127.6208	99.4744
1995	Jan	-0.1466	3.0336	-0.1152	1.6618	-0.0429	0.8327	-0.0854	1.7237	153.4271	111.4152	111.8732	94.3276	131.6304	106.8796	127.5118	101.1891
	Feb	-0.6448	-2.8517	-0.3963	-0.8717	-0.4273	-3.1567	-0.4575	-2.5683	152.4378	108.2380	111.4299	93.5053	131.0680	103.5057	126.9284	98.5903
	Mar	-0.9654	-2.3775	-0.4313	-0.3873	-0.3833	-0.3133	-0.5078	-0.8012	150.9662	105.6646	110.9493	93.1432	130.5656	103.1814	126.2839	97.8004
	Apr	-0.6088	1.0248	-0.3177	-0.1591	-0.4455	-1.3377	-0.4342	-0.4155	150.0471	106.7475	110.5968	92.9950	129.9840	101.8012	125.7357	97.3940
	May	-0.4474	0.7914	-0.6191	-1.7213	-0.4134	-0.0794	-0.4863	-0.5956	149.3757	107.5923	109.9120	91.3942	129.4467	101.7204	125.1242	96.8140
	Jun	-1.0674	-3.7966	-0.5429	-0.1965	-0.5694	-1.5965	-0.6514	-1.5038	147.7813	103.5075	109.3153	91.2147	128.7097	100.0964	124.3091	95.3581
	Jul	-0.4107	3.3241	-0.3372	0.5106	-0.6404	-1.1753	-0.4982	0.4759	147.1744	106.9482	108.9467	91.6804	127.8854	98.9200	123.6898	95.8120
	Aug	-0.2214	1.0780	-0.2871	0.7157	-0.2360	2.4436	-0.2498	1.6474	146.8486	108.1011	108.6339	92.3366	127.5836	101.3372	123.3808	97.3904
	Sep	-0.2598	0.4968	-0.3114	0.2536	-0.3368	-0.4190	-0.3139	0.0532	146.4671	108.6381	108.2957	92.5707	127.1539	100.9126	122.9936	97.4422
	Oct	-0.3944	-0.8682	-0.2628	0.2024	-0.3012	0.5630	-0.3057	0.2117	145.8894	107.6949	108.0111	92.7581	126.7710	101.4807	122.6176	97.6485
	Nov	-0.6561	-2.1081	-0.3962	-0.8343	-0.3209	-0.4765	-0.4075	-1.0484	144.9322	105.4246	107.5831	91.9843	126.3642	100.9972	122.1179	96.6247
	Dec	-0.5209	0.1521	-0.7910	-2.6239	-0.1196	1.4302	-0.4166	-0.4454	144.1772	105.5850	106.7322	89.5706	126.2131	102.4417	121.6092	96.1943
1996	Jan	-0.1124	2.3035	-0.1843	2.1195	-0.0098	1.1085	-0.0868	2.1544	144.0152	108.0172	106.5355	91.4691	126.2008	103.5773	121.5037	98.2667
	Feb	-0.2289	-0.2719	-0.0724	0.9973	-0.1411	-0.5470	-0.1363	0.1151	143.6856	107.7235	106.4584	92.3813	126.0227	103.0107	121.3381	98.3798
	Mar	-0.1149	0.9341	-0.0972	1.2715	0.0074	1.0659	-0.0513	1.0658	143.5205	108.7297	106.3549	93.5560	126.0320	104.1086	121.2758	99.4284
	Apr	-0.2322	-0.8363	-0.0252	0.5516	-0.1155	-0.9588	-0.1060	-0.3915	143.1872	107.8204	106.3282	94.0720	125.8864	103.1105	121.1473	99.0391

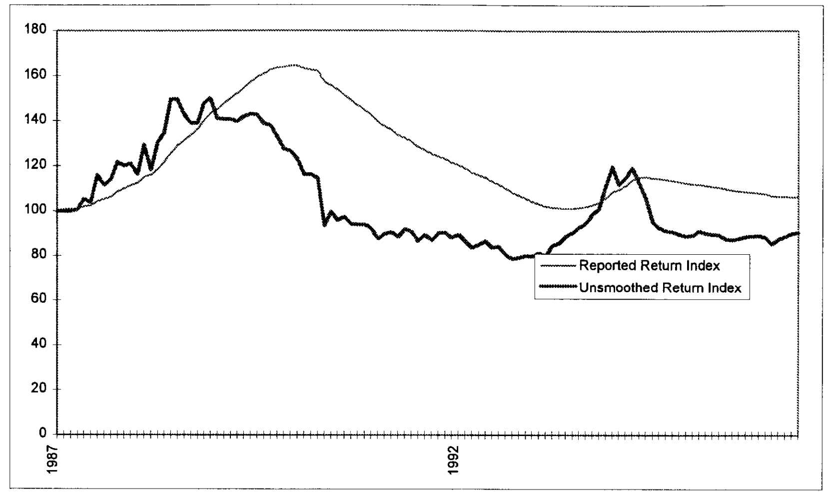
Appendix V

Calculation of Unsmoothed Returns and Indices

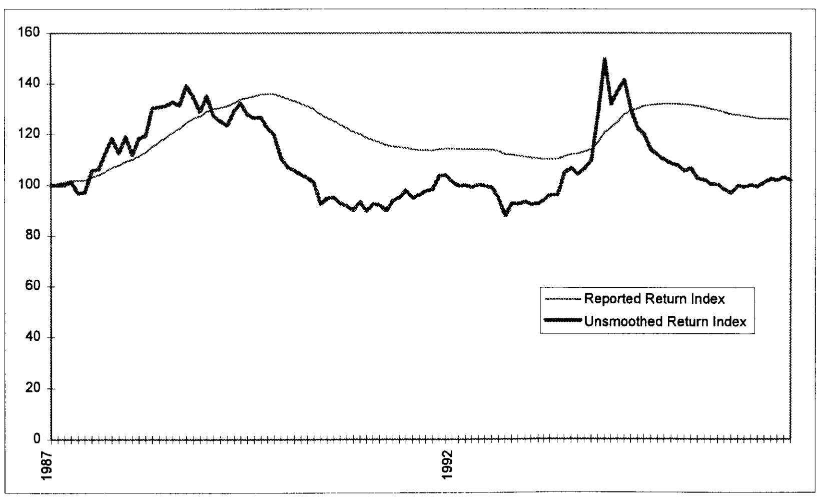
Industrial Sector



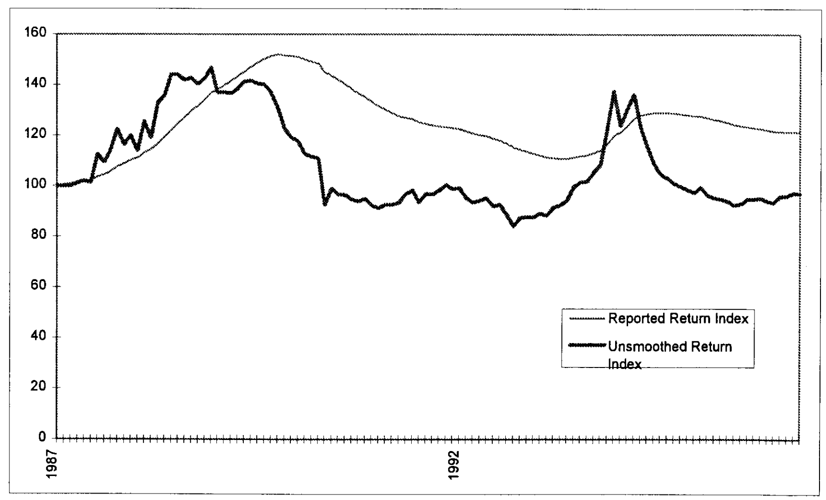
Office Sector



Retail Sector



All Property Sector



Appendix VI

Reported Return vs. Unsmoothed Returns

Industrial

1 / 90 - 12 / 94

Multiple R .93908
R Square .88187
Adjusted R Square .84160
Standard Error .01577

Company Name	Beta Coefficient	t-stat	Primary Business Activity
Compass Group	0.265169	-5.807	Industrial Catering contractor
Dalgety, PLC	0.232024	-4.424	Food manufacturer and Dist.
Dawson International	-0.19808	-6.251	Textile Manufacturer
Johnson Group	0.253835	-4.986	Dry Cleaner and Linen Rental
Rank Organisation	-0.276595	-5.46	Holding Company / Manufacturer
Salvesen Christian	-0.130593	-2.913	Food and Brick Manufacturer
Sedgwick Group	0.174113	-6.25	Insurance broker / Property Manager
Smith & Nephew	-0.104951	-2.118	Pharmaceutical manufacturer
Tesco. PLC	-0.253987	-5.72	Food Proprietors
Wolseley, PLC	0.161705	-3.908	Sanitaryware manufacturing
Zeneca Group	0.36809	-4.749	Manufact. of Pharm. and Agriculture
Berisford, PLC	0.086916	-6.688	Prop. dev., Food and Agribusiness
Provident Financial	-0.204466	-4.297	Holding company
Daejan Holdings	0.193277	-3.165	Property company
Town Centre Securities	-0.114242	-2.726	Property company
Constant	-0.002379	-0.988	

Retail Sector

1 / 90 - 12 / 94

Multiple R .96074
R Square .92302
Adjusted R Square .89678
Standard Error .01522

Company Name	Beta Coefficient	t-stat	Primary Business Activity
William Baird, PLC	-0.630418	-13.842	Garment Manufacturer and Retailer
Caradon, PLC	0.268258	7.707	Central Heating
Dawson International, PLC	-0.226307	-6.452	Textile Manufacturer
Sedgwick Group, PLC	0.227638	8.65	Insurance Broker / Property Manager
Smithkline Beecham, PLC	-0.33914	-8.897	Pharmaceuticals
Tate & Lyle, PLC	-0.16019	-3.769	Holding Company
Cowie Group, PLC	0.138054	5.556	Car Dealer, Household retailers
Takare, PLC	0.084955	2.449	Medical Care
Argyll Group, PLC	0.109905	2.752	Retail Food
Dencora	0.093813	3.124	Property Company
Ocean Group, PLC	-0.115353	-3.581	Distribution Services
Cordiant, PLC	-0.083759	-4.685	Advertising
Babcock International Group	-0.117385	-5.187	Holding Company
Hazlewood Foods, PLC	0.158433	5.631	Food Manufacturing
The RTZ Corporation	0.283284	6.652	Metal Stockholder
Constant	-0.002921	-1.33	

Office Sector

1 / 90 - 12 / 94

Multiple R .92262
R Square .85122
Adjusted R Square .80050
Standard Error .01947

Company Name	Beta Coefficient	t-stat	Primary Business Activity
British Airways. PLC	0.075579	1.652	Air Transport
Dawson International, PLC	-0.175742	-4.822	Textile Manufacturer
Linton Park, PLC	0.233299	5.748	Holding Company
MFI Furniture Group	0.123782	1.941	Furniture Retailers
Powell Duffryn, PLC	0.129318	2.485	Holding Company
Queens Moat Houses	-0.143452	-3.517	Holding Company
Rolls-Royce, PLC	-0.133623	-3.511	Industrial Engine Manufacturer
Tate & Lyle, PLC	-0.241727	-4.269	Holding Company
Waste Management Internation	-0.131184	-3.457	Refuse Disposal
Willis Corroon Group, PLC	0.238404	7.252	Industrial assurance
Wolseley, PLC	0.244999	4.474	Plastics
Evans Halshaw Holdings, PLC	0.146237	3.292	Motor Vehicle Dealer
Provident Financial, PLC	-0.101624	-1.762	Holding Company
Land Securities	-0.315542	-4.743	Property Company
Trafford Park Estates	0.197983	6.08	Property Company
Constant	-0.008793	-2.848	

All Property Sectors

1 / 90 - 12 / 94

Multiple R .91827
R Square .84323
Adjusted R Square .78978
Standard Error .02120

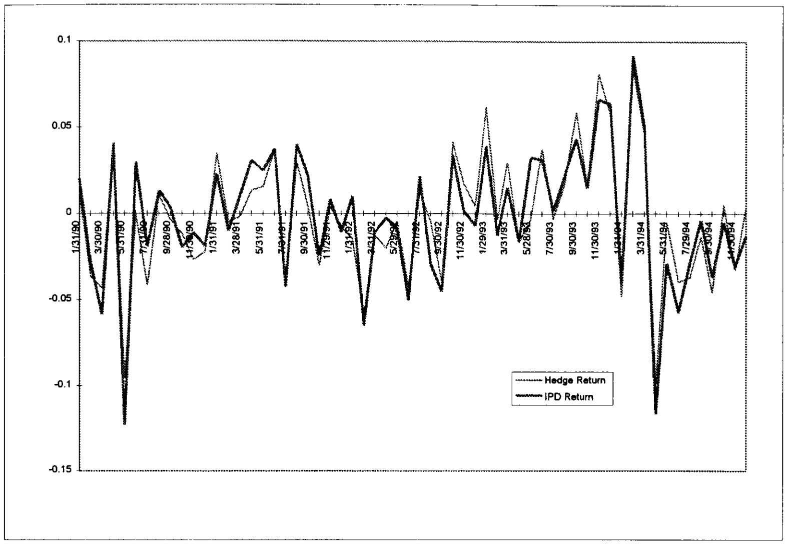
Company Name	Beta Coefficient	t-stat	Primary Business Activity
Dawson International	-0.206762	-4.731	Knitting Wool Manufacturer
FKI, PLC	0.143015	3.909	Electronic Manufacturer
Forte, PLC	0.139625	2.415	Hotel Licensed
Hanson, PLC	-0.341297	-4.816	Electronic Manufacturer
Hillsdown Holdings	-0.201489	-4.746	General Food
Inchcape, PLC	-0.109967	-1.879	Motor Accessories
Retail Corporation	0.308094	3.853	Boots and Shoes
Signet Group	-0.110057	-5.441	Jeweller
Transport Develop Group	-0.200644	-4.036	Transportation
George Wimpey, PLC	0.127504	2.771	Land and Building Company
Wolseley, PLC	0.489012	7.52	Sanitaryware/Plastics Manufacturer
Zeneca Group	0.296849	3.223	Patent Medicines
Westland Group	0.302759	6.328	Electronic Manufacturer
Evans Halshaw Holdings	0.196223	4.741	Motor Vehicle Importer
Provident Financial, PLC	-0.284859	-4.403	Holding Company
Constant	-0.019041	-5.459	

Appendix VII

Static Replicating Hedge Regression Results

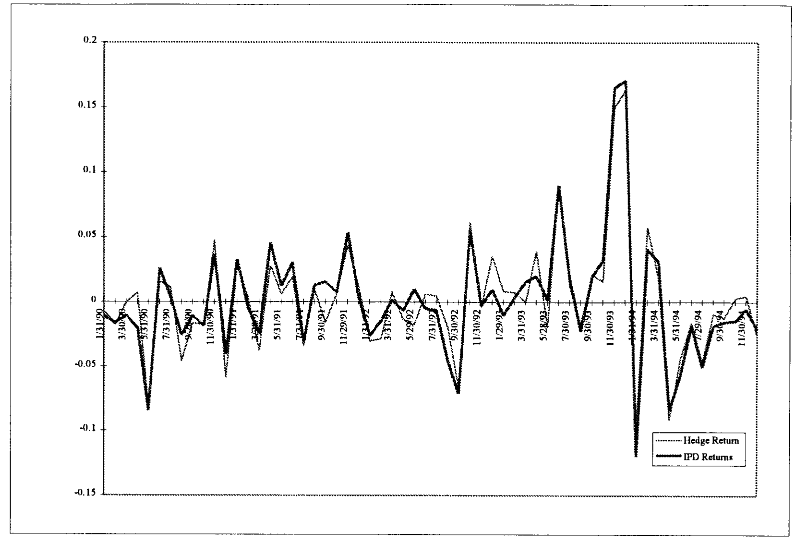
Industrial Sector

1 / 90 - 12 / 94



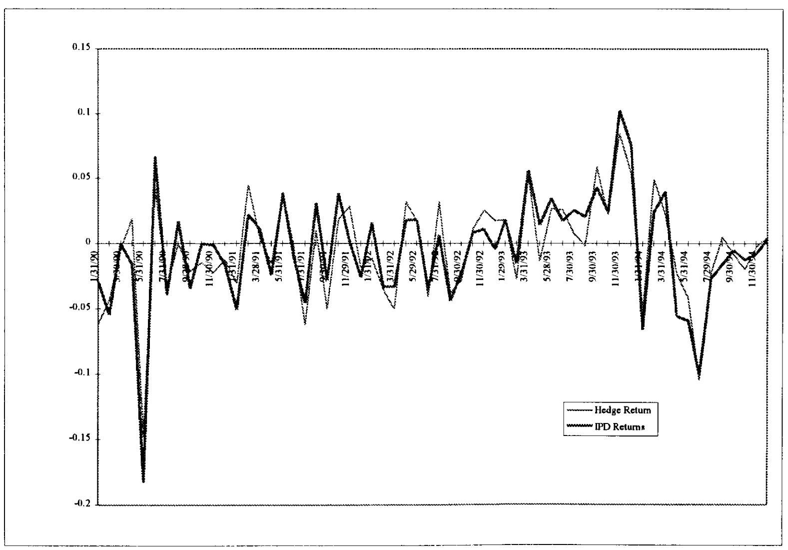
Retail Sector

1 / 90 - 12 / 94



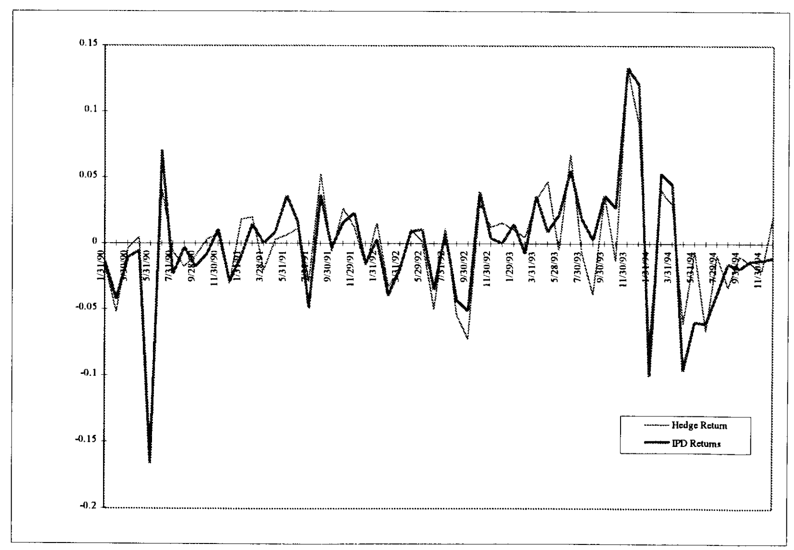
Office Sector

1 / 90 - 12 / 94



All Property Sector

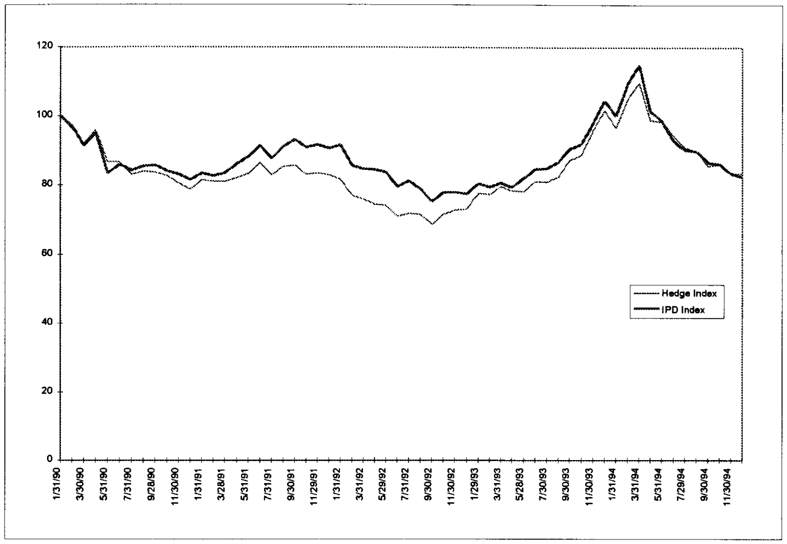
1 / 90 - 12 / 94



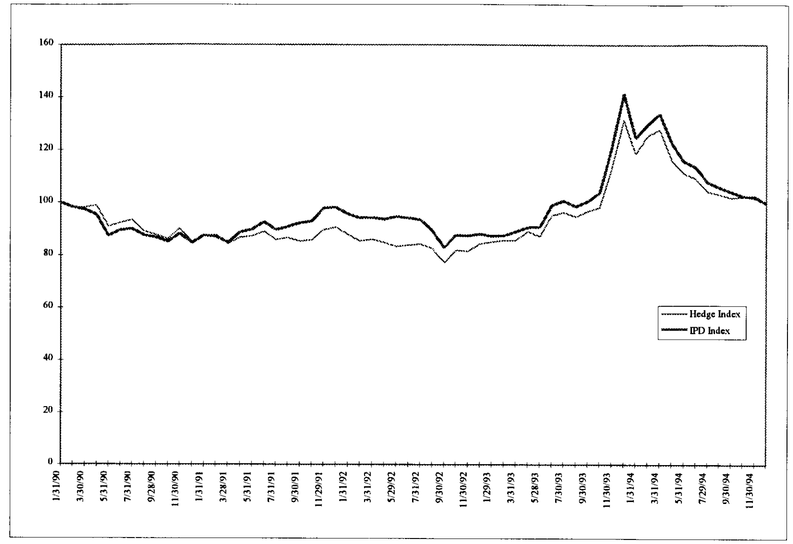
Appendix VIII

Replicating Hedge Returns vs. Unsmoothed IPD Returns

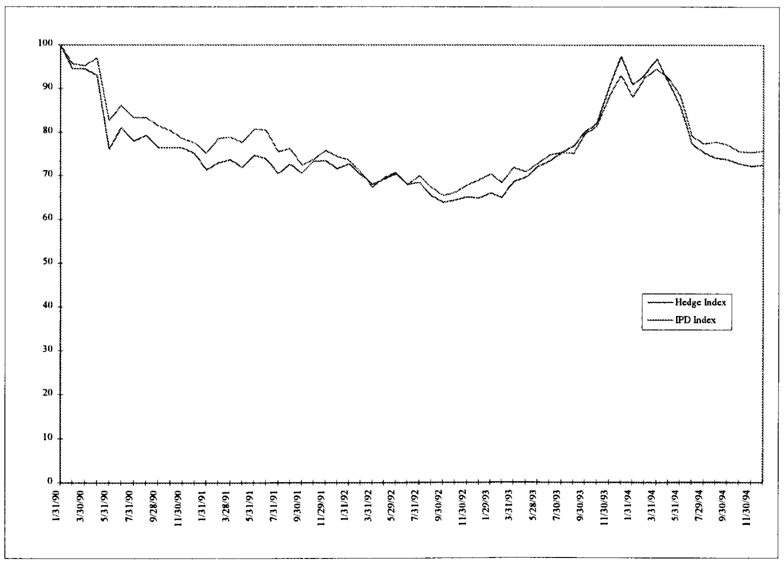
Industrial Sector
1 / 90 - Industrial



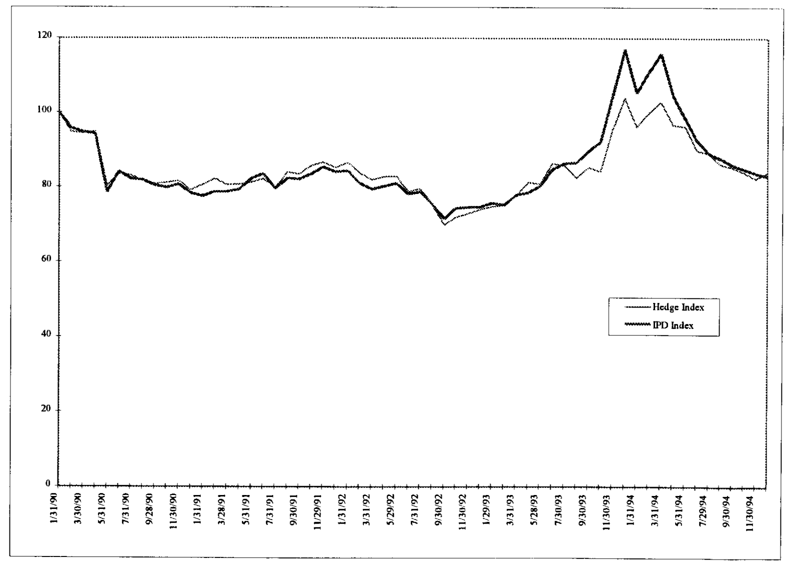
Retail Sector
1 / 90 - 12 / 94



Office Sector
1 / 90 - 12 / 94



All Property Sector
1 / 90 - 12 / 94



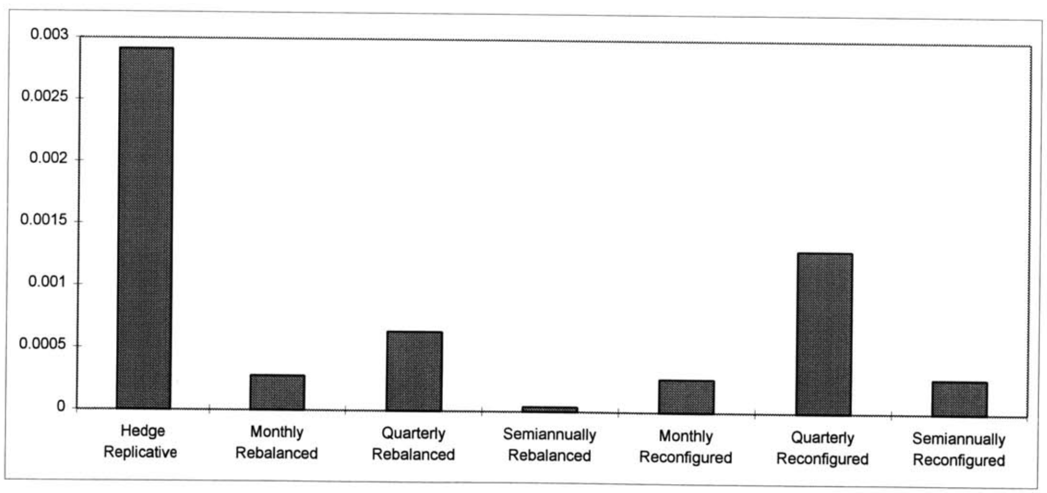
Appendix IX

Static Replicating Hedge Indices vs. Unsmoothed IPD Indices

All Property
Error Terms Analysis

Date	Replicative Hedge	Rebalanced Monthly	Rebalanced Quarterly	Rebalanced Semiannually	Reconfigured Monthly	Reconfigured Quarterly	Reconfigured Semiannually
1/31/95	0.01349	-0.01789	-0.01789	-0.01789	-0.00969	-0.00969	-0.00969
2/28/95	0.02541	0.00892	0.00892	0.00892	0.00892	0.02753	0.02753
3/31/95	-0.00308	-0.00093	-0.01938	-0.01938	-0.00093	-0.00093	-0.00093
4/28/95	0.04693	-0.01636	-0.01636	-0.01669	-0.00989	-0.00989	-0.00989
5/31/95	0.00794	-0.00338	-0.01400	-0.01420	0.00045	-0.05516	0.00031
6/30/95	0.00987	-0.00153	-0.00102	-0.00102	-0.00153	0.10694	-0.10193
7/31/95	-0.04222	-0.01148	-0.01148	-0.01148	-0.01148	-0.01148	-0.01148
8/31/95	0.11782	-0.01109	-0.01109	-0.01109	-0.01109	0.07065	0.07065
9/29/95	-0.02689	-0.00407	0.01981	0.01981	-0.00407	-0.01587	-0.01587
10/31/95	-0.02214	0.01322	0.01322	0.01537	0.01322	0.01322	0.03468
11/30/95	-0.17172	0.00555	0.00555	0.00935	0.00555	-0.09344	-0.00074
12/29/95	0.05484	0.01080	0.01080	0.01414	-0.00760	-0.02958	-0.00369
1/31/96	0.02760	0.02467	0.02467	0.02467	0.02467	0.02467	0.02467
Average	0.00291	-0.00028	-0.00064	0.00004	-0.00027	0.00130	0.00028
St Deviation	0.06660	0.01253	0.01531	0.01591	0.01087	0.05097	0.03931

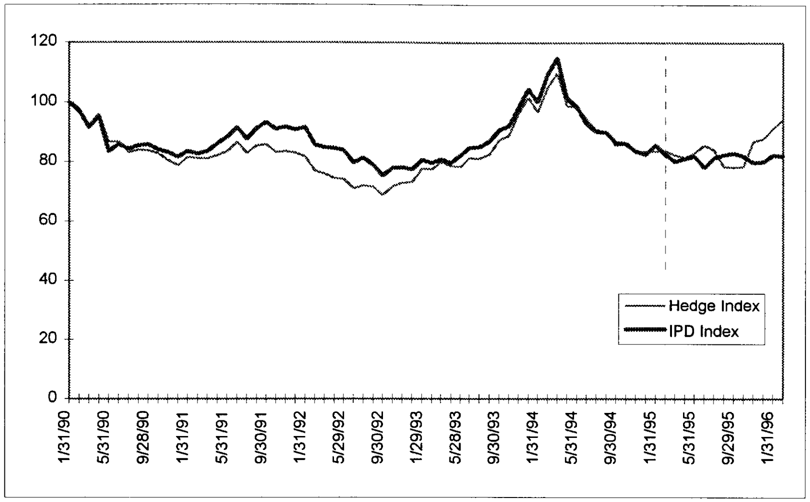
Absolute Values of Error Term Averages



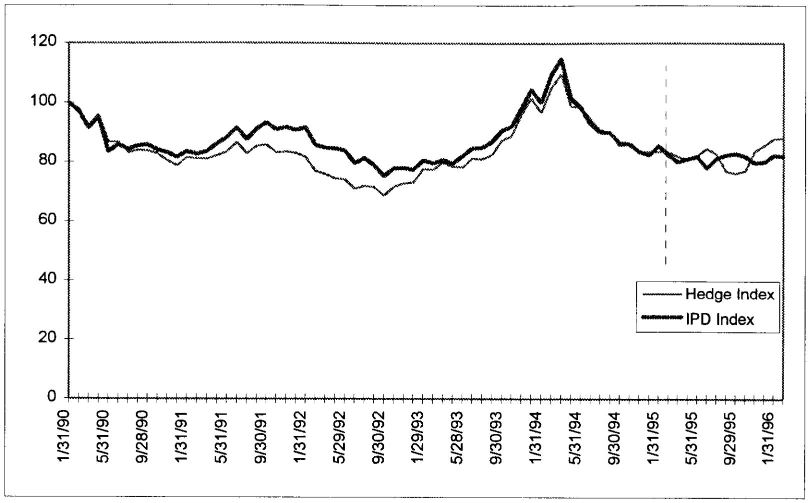
Appendix X

All Property Sector Predictive Hedge Error Terms

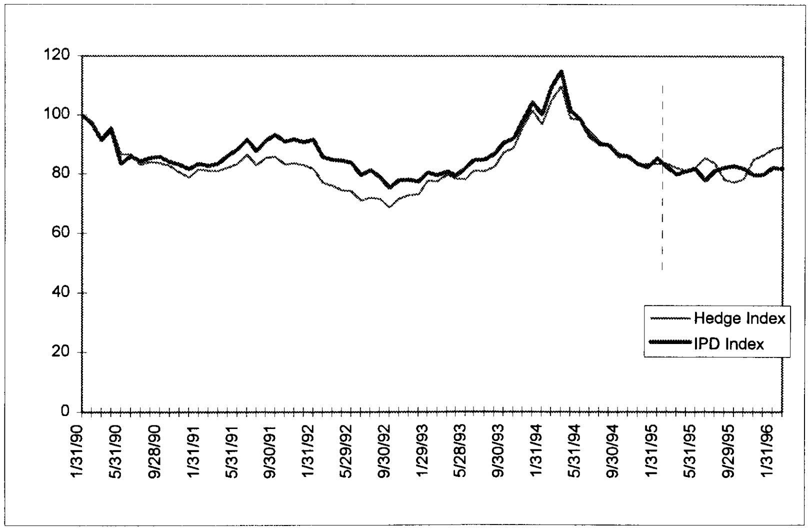
Industrial Sector
Static / Replicating Hedge



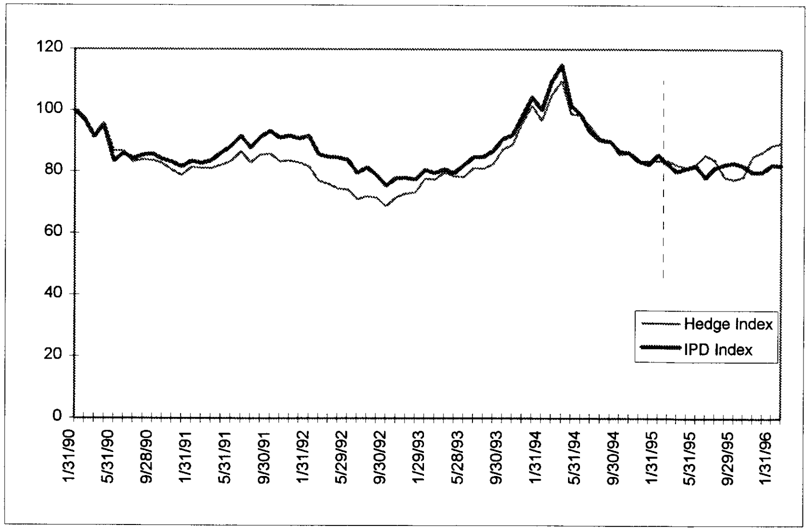
Rebalanced Monthly



Rebalanced Quarterly



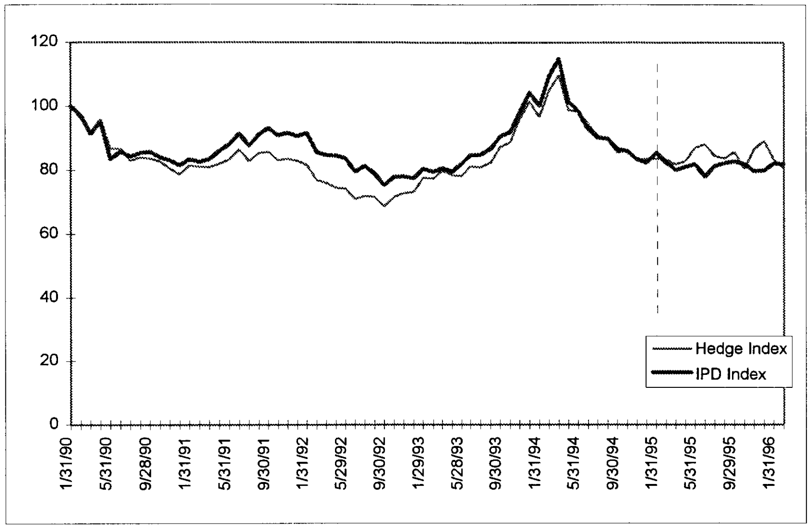
Rebalanced Semiannually



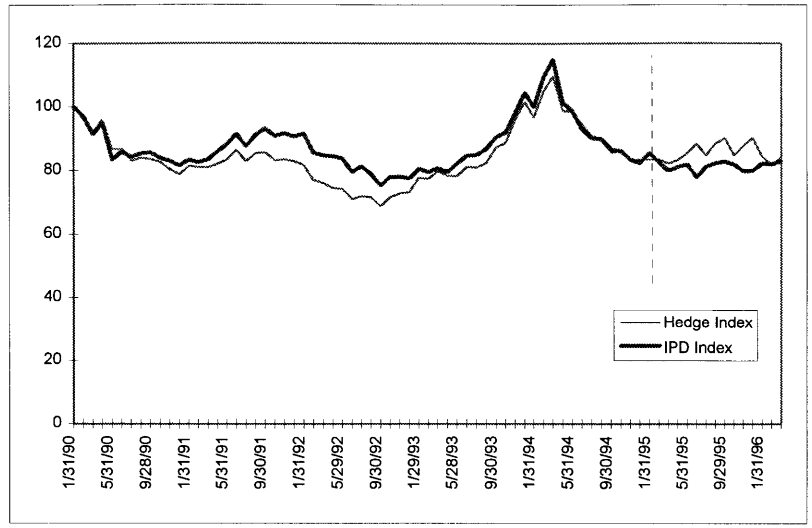
Appendix XI

Industrial Sector: Static and Rebalanced Hedges

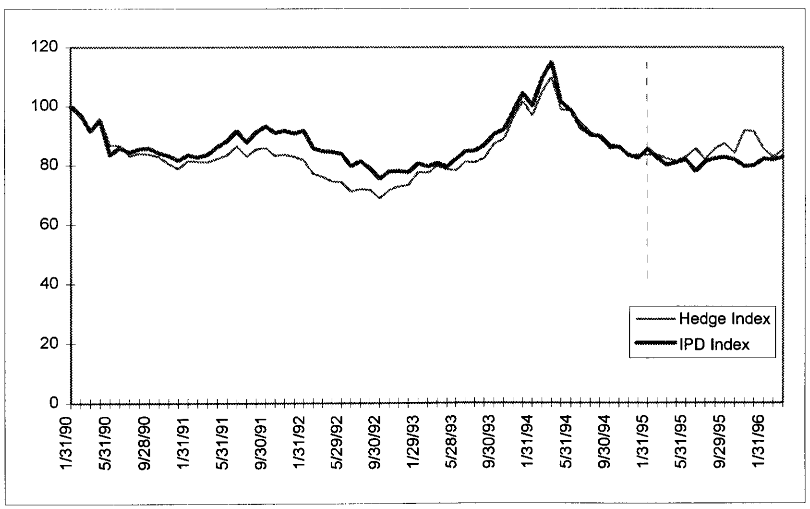
Industrial Sector
Reconfigured Monthly



Reconfigured Quarterly



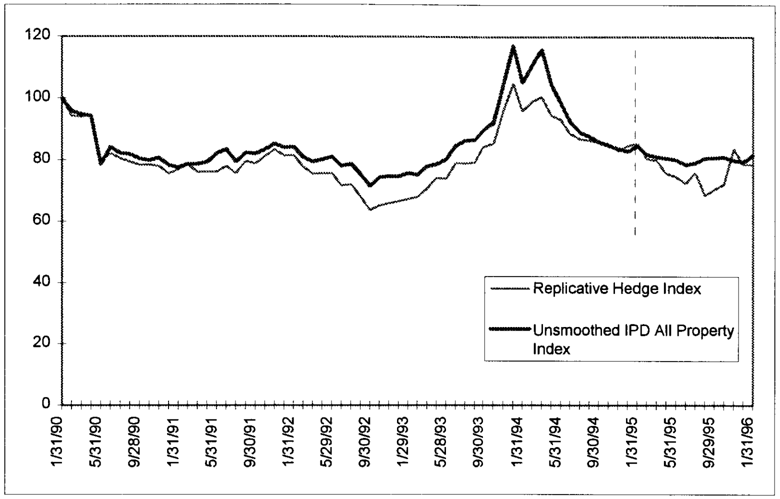
Reconfigured Semiannually



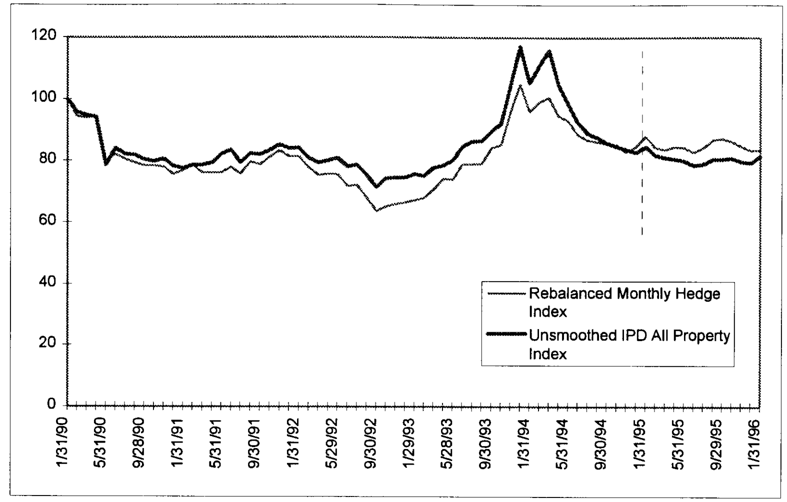
Appendix XII

Industrial Sector: Reconfigured Hedges

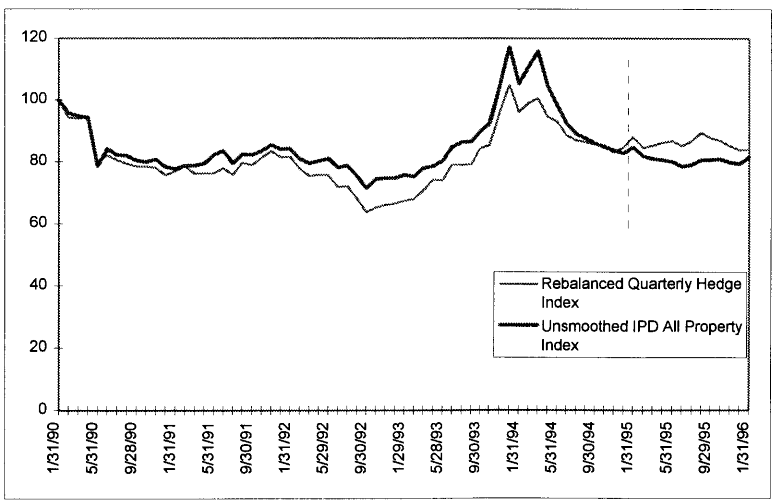
All Property Sector
Replicative Hedge



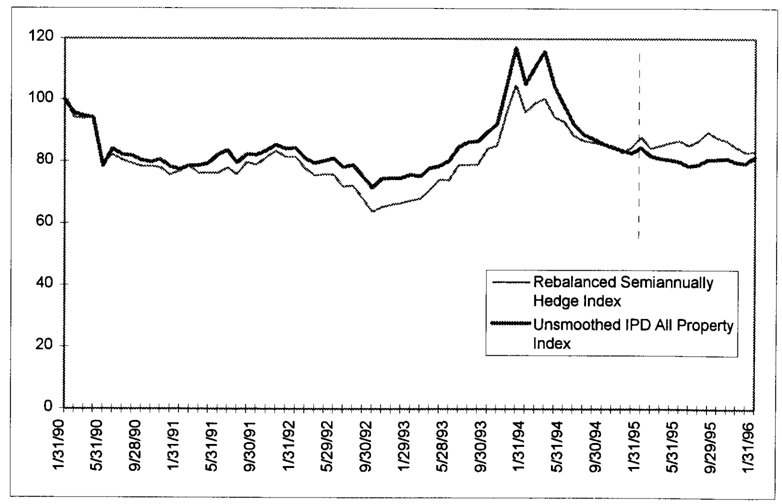
Rebalanced Monthly



Rebalanced Quarterly



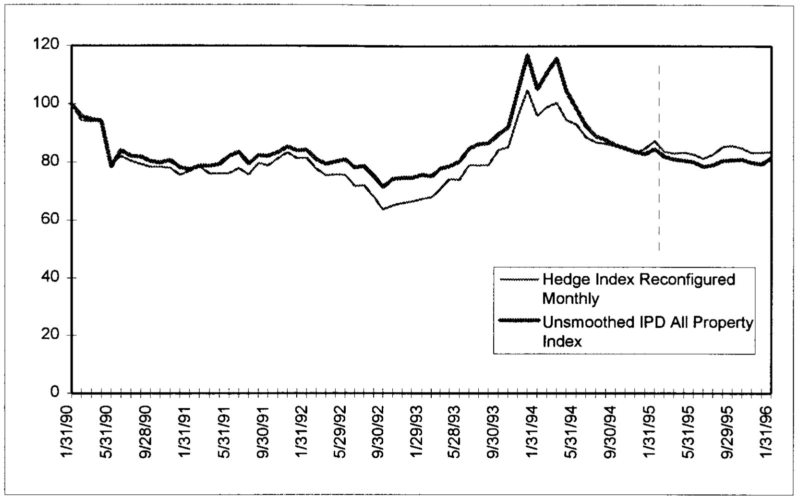
Rebalanced Semiannually



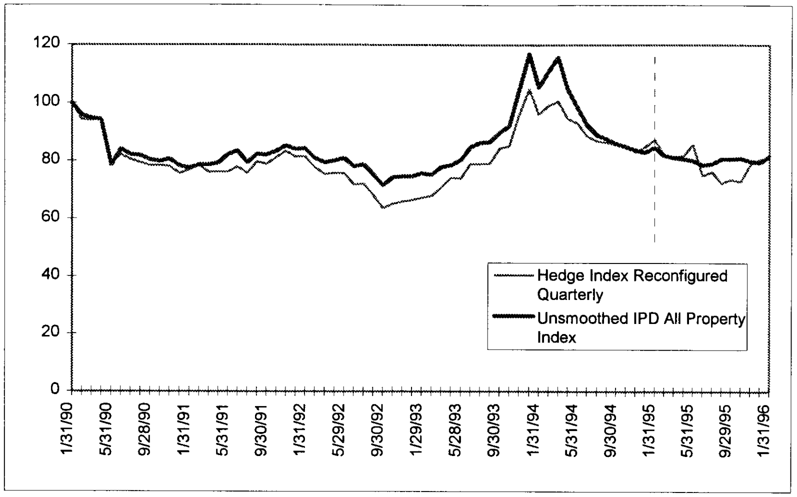
Appendix XIII

All Property: Replicative and Rebalanced Hedges

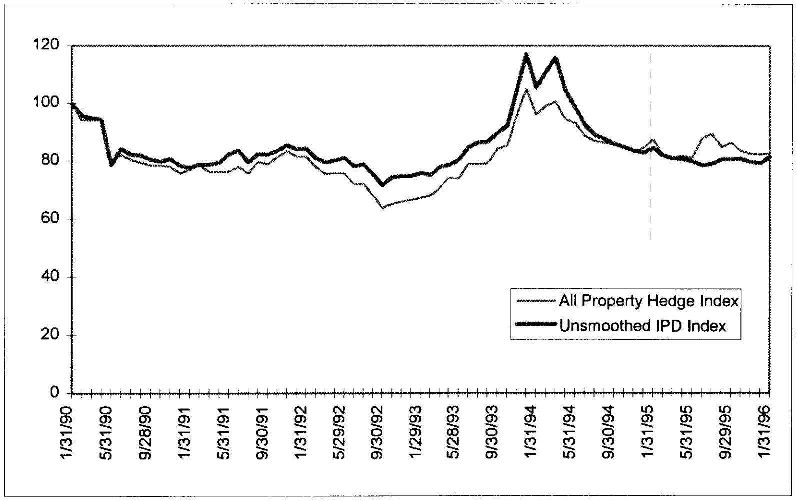
All Property Sector
Reconfigured Monthly



Reconfigured Quarterly



Reconfigured Semiannually



Appendix XIV

All Property: Reconfigured Hedges