

THE EFFECT OF GEOGRAPHIC DIVERSIFICATION ON THE RETURNS
OF REAL ESTATE INVESTMENT TRUSTS - AN ANALYSIS

by

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by

WILLIAM BRADFORD MCMILLAN, JR.

Submitted to the Department of Architecture on July 31, 1992
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ABSTRACT

In analyzing the effect of geographic diversification on the risk and volatility of real estate returns, past studies have suffered from several flaws. They have been performed on ex post portfolios constructed from a larger sample of properties, they have used appraisal-based return series, and the geographic regions analyzed did not bear any relation to the economic characteristics which underlie real estate. The results of such research have been largely inconclusive in determining whether geographic diversification in fact represents a possibility for reducing the risk profile of real estate investment.

Real estate investment trusts are a real estate ownership vehicle which is liquid, priced on a daily basis, and which represents an interest in an underlying portfolio of real estate. Since the governing legislation requires that 95% of all income be passed through to the security holders, ownership interest in a REIT represents a close proxy in income characteristics for the performance of real estate. Capital appreciation, the second major component of real estate returns, is also strongly linked to the performance of the real estate, although here stock market effects come into play as a REIT share, like any tradable security listed on an exchange, is subject to market forces.

Because REITs represent an ownership interest in a defined portfolio of real estate, are priced in the capital markets on a daily basis, and can be broken down on a geographical basis to test any proposed geographic diversification scheme, they represent a chance to draw conclusions about the effect on real estate returns of such diversification, and the degree to which such diversification reduces risk. If stock market effects are accounted for and removed from the analysis, the remaining performance factors can be assumed to represent the underlying real estate, and an analysis can be made of the degree to which geographic diversification has affected the volatility of the returns.

I researched and calculated a concentration index for each REIT on a quarterly basis over the period from 1980 to 1989. I then analyzed both the variance in the returns and the relationship of average returns to the variance of the returns. I also analyzed the returns themselves over one, two, and five-year periods with respect to the concentration index.

My conclusions were that the Hartzell-Shulman-Wurtzebach model provides a context for genuine scientific diversification for real estate over periods of five years or longer, explaining in a statistically significant way the variance of the returns. Over shorter time periods, the data is too noisy for diversification to be significant in explaining variance. The variance of returns appears to affect the level of returns, which is consistent with expectations and which indicates that the concentration index should have a direct link with returns. Finally, the concentration index also appears to explain the level of returns over longer time periods, although this was not statistically significant.

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of Real Estate Investment Trusts - An Analysis

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CHAPTER ONE - DEFINING THE PROBLEM

Problem Definition

The purpose of diversification is to reduce risk. By having eggs in several baskets, rather than just one, the downside of any particular disaster can be minimized. Conversely, the upside of any spectacular success is also lessened. The effect of diversification is to reduce the range of possible outcomes.

Modern portfolio theory (MPT) is the mathematical backing behind the idea of diversification. The core of MPT is the Capital Asset Pricing Model (CAPM), which states that risk which is specific to any asset can be diversified away, by buying assets which do not respond to the same factors as the first asset. The two assets are therefore uncorrelated. The only remaining risk is that which affects the system as a whole.

In the securities markets, the CAPM and MPT are well tested and proven, because they are efficient markets with homogeneous assets which are easily amenable to mathematical treatment in the MPT framework. Real estate is different, with heterogeneous assets, incomplete information, and high transaction costs. As an inefficient market, the data does not exist for the types of mathematical tests which allow MPT to be used in the capital markets.

Research in applying MPT to real estate markets has been based on limited return series which were not based on actual transactions. Previous research has largely dealt with returns calculated based on appraised values. It has been shown that appraisal bias tends to result in smoothing of returns, as well as lagging behind changes in market return requirements [12, p.48] [13, p.260]. The effect of these two factors is to lower the amplitude and extend in time the changes in returns due to capital gains or losses on real estate, thus understating the volatility of real estate as an asset class and of the sample of properties used in such research. By basing an analysis on an artificially low level of volatility in returns, factors which might act to lower actual volatility are lost in the damping effect of appraisal bias. Therefore, in testing the effect of diversification on the performance of a portfolio of real estate assets, the effect is lost or moderated. Therefore such factors cannot be effectively measured using such an appraisal based return stream.

Previous research has also dealt with large samples of properties from which ex post portfolios were constructed, rather than following the course of an evolving portfolio as it changed and evaluating the performance based on those changes. By constructing a portfolio ex post, the analyst introduces bias which is not present when a defined portfolio is tracked over time. Also, the tracking of several portfolios of varying composition allows an empirical test of

the effects of diversification which is not possible when examining a single portfolio ex post.

The focus of this past research has been to examine the returns of properties within a portfolio, and ascertain methods of finding properties with uncorrelated returns - that is, diversification criteria. The most elaborate and successful of these has been the Hartzell, Shulman, and Wurtzebach model, which divides the country into eight economically distinct regions, with different unsystematic risk factors.

The purpose of this thesis is to test whether the Hartzell, Shulman, Wurtzebach model of the United States represents a valid basis for geographic diversification in real estate investment. In order to do this, the data set to be evaluated must meet several criteria. First, the data used must cover enough of the eight regions to make a meaningful evaluation of their relevance possible. Second, the portfolios to be analyzed must be traceable over time for both performance and composition within the model. Lastly, the performance must be evaluable on the basis of market transactions.

Real estate investment trusts (REITs) fulfill all of these criteria. Typically, REITs cover at least two of the regions as defined by Hartzell et al., and often more. Careful selection of sample REITs can ensure that adequate geographic disparity is present for analysis purposes.

Secondly, data is available through publicly available 10K reports for the geographic composition of the REIT portfolio, based on acquisition cost and costs capitalized subsequent to acquisition. It is, therefore, possible to track the geographic diversification within the portfolio over time along with the corresponding performance of the portfolio. The final criterion, that performance is evaluable based on market transactions, is satisfied by REITs due to their nature as exchange traded securities.

The fact that REITs satisfy all of the above criteria makes them candidates for selection, but there are several problems which must be resolved with such data sources. The first is that of the influence of non-real estate factors such as stock market effects on the performance of REIT shares. It is likely that stock market factors play a significant role in REIT performance, and thus must be accounted for in any analysis of real estate specific factors in REIT performance. The next problem is that of tracking diversification by value in a portfolio, where values may change from acquisition costs.

These problems are real, and are dealt with in our analysis. Stock market factors are considered in our analysis, while value diversification is based on the 10K report data as to acquisition costs and capitalized expenditures subsequent to acquisition.

Questions To Be Answered

This study analyzes the following questions:

1. Does geographic diversification explain the variance of real estate returns?
2. If so, does it also affect the returns themselves?
3. Over what periods does diversification act?

CHAPTER TWO - REAL ESTATE INVESTMENT TRUSTS

Definition of a Real Estate Investment Trust (REIT)

What is a REIT? A REIT is a corporation, business trust, or association primarily developed to own or finance real estate. A board of trustees, elected by shareholders, sets policy and arranges for day-to-day operation by professional managers. [1, pp.23-25]

Real estate investment trusts (REITs) differ from a typical public corporation principally in that they pay no federal tax on income or gains passed through to the shareholders. In this, they act as closed end mutual funds investing in real estate, acting as an intermediary for buyers of real estate. Closed end funds issue shares which trade on the secondary market, and issue new shares periodically. In this, they act like a corporation. As intermediaries, however, REITs pay no taxes on income passed through to shareholders. [2]

In order for a corporation to qualify as a REIT and maintain its privileged tax status, it must follow a strict set of legal requirements. The primary requirements are the following:

- Must be a corporation, business trust, or association
- Must have at least 100 shareholders

- During the last half of each taxable year, must have no more than 50% of all shares owned by 5 or fewer individuals
- Must report on a calendar year basis
- Must be managed by a board of trustees or directors
- Must distribute 95% of net annual taxable earnings to shareholders
- Must derive at least 75% of its annual gross income from real estate activities, including rents, mortgage interest, gains from selling real estate, and dividends from investing in other REITs
- Must hold at least 75% of its total invested assets in real estate (including fee interests, leasehold, options, loans secured by real property, and shares in other REITs)
- Less than 30% of annual gross income must come from gains from sale of certain property held less than four years and short-term gains from sale of securities and other miscellaneous items

The last requirement effectively prohibits a REIT from actively holding property for sale, such as developing and selling single family homes for example.

Another critical element of the IRS requirements is the definition of "income derived from real estate." Real property rents are included in the definition, but may be disallowed if the REIT manages or operates the property itself instead of having an independent contractor manage or operate it. The REIT must act as a passive investor rather than an active participant.

REITs typically have an advisory firm which acts as manager of either or both the REIT itself and the properties. In many cases, the advisor is affiliated with the company or entity which originally formed the REIT and collects a fee for its services. This restriction on management makes it very difficult for a REIT to act as a developer, since it can not directly operate or manage property.

These restrictions were made less onerous by the Tax Reform Bill of 1986, but persist in restricting the role of the REIT management. In general, these restrictions are designed to insure that REITs will invest in real estate assets on a long-term, not speculative basis.

Industry History

REITs are patterned after a form of business organization known as a Massachusetts business trust, and have existed in that form since the nineteenth century. Following a 1935 federal court ruling causing business trusts

to be taxed as corporations, their numbers declined until they were specifically authorized by Congress in sections 856-858 of the Internal Revenue Code in 1960, an authorization which later became known as the Real Estate Investment Trust Act of 1960. [2, p. 16] This act exempted business trusts from corporate taxation provided they complied with the requirements listed above.

In the early 1960s, REITs grew slowly. Between 1961 and 1967, the only legal form of REIT was the equity REIT, which directly invested in real property. In that time period, only 38 REITs were formed. In the late 1960s and early 1970s, however, the industry grew at an explosive pace, with assets increasing by almost twenty times from 1968 to 1973, from approximately \$1 billion to just under \$20 billion [3, p.8]. From 1968 to 1973, 209 equity REITs and 113 mortgage REITs were formed. Many large banks formed REITs during this time period and acted as advisors to their captive REITs, using these REITs to make high-risk real estate loans which the banks, heavily regulated, could not have made themselves. [2, p.17-18]

This growth was primarily spurred by lack of credit from traditional sources, and was largely financed by short term commercial paper and bank notes. Because REITs could access the capital markets directly, they could produce funds more easily than traditional lenders who relied on deposits for capital, and could engage in yield arbitrage between the

capital market rates and the prevailing real estate lending rates. The largest growth was in construction and development (C&D) loans, which were intended to be short term. The growth spurt ended abruptly in 1974, when rising interest rates and a severe slowdown in the real estate industry resulted in negative spreads between the short term borrowings and the outstanding loans. The REITs found themselves foreclosing on properties and unable, due to lack of liquidity in the markets, to liquidate these assets in order to pay off their short-term liabilities and cover the negative spreads. Many REITs were forced to declare bankruptcy, and the National Association of Real Estate Investment Trust's (NAREIT) share price index dropped to one third of its 1972 high in 1974. In addition to the collapse of their market, REITs also faced an accounting loss. Since REITs had no loan-loss reserve provisions, the markdown in the book values of the REITs destroyed shareholder equity.

Since that time, the industry has staged a slow comeback. Total assets invested in REITs declined initially, then remained flat within the \$7 billion range from 1978 to 1983. Returns generally improved and stayed strong during that time period, with a couple of bad years. As investor confidence returned, the market for REITs improved and in 1985 29 new offerings were made in the capital markets. The Tax Reform Act of 1986 (TRA'86) also favored the recovery of the REIT industry by loosening some of the legal requirements on REITs. It expanded the services a REIT could perform

directly rather than through an independent contractor, liberalized the definition of qualified income, and allowed a longer time to invest new assets in qualified investments. TRA '86 also eliminated the tax advantages of many tax-driven real estate limited partnerships, giving REITs, which are income securities, a comparative advantage with respect to other forms of real estate investment, which had benefited from the liberal depreciation allowances allowed under the earlier tax code.

At the present time, the REIT industry remains relatively healthy with respect to the late 1970s and early 1980s, but not as robust as during the early 1970s. Total leverage is much less, with a much more conservative investment orientation, one oriented much more toward equity investment and long-term mortgages. Less than 1% of REIT assets are in C&D loans.

Classification of REITs

REITs are typically classified by their asset holdings. Standard definitions are those provided by the industry trade association, the National Association of Real Estate Investment Trusts (NAREIT). Equity REITs are defined to have 75% of their assets in the ownership of real estate or the shares of other REITs, mortgage REITs have at least 75% of their assets in mortgages secured by real estate, and hybrid

REITs hold some combination of the two asset classes. REITs are not further classified by NAREIT with respect to asset class, location, or financial structure. Further distinctions which can be drawn include the property type or geographic area in which a given REIT invests. A recent type of REIT is a finite life REIT, with a defined life after which the properties will be sold and the REIT closed out.

Sources of REIT Returns

Because of the legal structure of REITs, returns are driven by factors similar to those of other real estate. 95% of all cash flows must be passed through to the investors. Since this includes property operating cash flows as well as capital gains on resale, and the investor is taxed personally on the cash flows rather than doubly taxed as he would be in a corporate form of ownership, the net effect to the investor is that he enjoys the income and appreciation benefits accruing from the ownership of real property while not being encumbered with the management and investment decisions which would be involved in actual property ownership. Therefore the REIT stocks represent a real estate investment in terms of the cash returns they provide. Cash flow and gains flow through to the investors just as they would in a direct property investment.

A REIT adds another component of risk and return, however, which is not present in a direct property investment - the effect of the stock market. A publicly traded security has a number of differences from a direct real estate investment such as liquidity, homogeneity, an expanded universe of comparable investments, reduced transaction and information costs, and many others. [5, p.246] While investors in real estate have made a decision to be in real estate and must work within that market framework, an investor in a security must evaluate his risk/reward decision against other securities available in the market.

For this reason, while the returns in the form of cash flows represent a real estate investment, the decision criteria and thus the pricing criteria of a REIT share are driven by different sets of investment criteria. The real estate market, unlike the stock market, is not an auction market with divisible shares in properties, and information is not freely available. This makes real estate much more dependent on investor judgment. [10, p.23] Therefore, because a REIT offers real estate returns but in a market framework different from that which applies to a direct property investment, stock market factors must be considered in evaluating a REIT's total risk/return spectrum. The integration of equity REIT shares in the stock market was confirmed in a 1990 study: "... we find that equity REITs are integrated with the stock market, but the commercial real estate that underlies these equity REITs is segmented from

the stock market." [4] In this context, integration was defined as the absence of a premium for real estate market risk, while segmentation indicated that the only risk priced for real estate is the systematic risk relative to the commercial real estate market. The result of this study, therefore, was that investors would expect to earn the same risk-adjusted return on equity REITs as in the stock market as a whole, while commercial real estate would not necessarily display the same risk adjusted return as the stock market.

The separation of the commercial real estate market from the stock market was also confirmed, where it was found that nearly 90% of real estate risk is non-systematic (property specific factors dominate). [5, p.248] The connection of the equity REIT to the stock market was also confirmed by another study [10, p.30], where a correlation of 0.78 was calculated between the NAREIT Equity REIT index and the S&P 500 index. Further confirmation is found in the fact that equity REIT returns display the same volatility as common stocks. [11, p. 17] Other studies which have confirmed that equity REIT prices track the stock market are references 14 and 15. In analyzing the returns of equity REITs, therefore, it is necessary to adjust for the effects of the stock market to discern the performance of the underlying real estate.

CHAPTER THREE - DIVERSIFICATION

The Capital Asset Pricing Model (CAPM)

The essential idea behind the CAPM is that risk can be mitigated by diversification. Risk is defined in the model as the degree of variability that the returns of an asset display. In the CAPM there are two types of risk: systematic and unsystematic. Systematic risk refers to all risks which are inherent to the entire system. In a stock market context, systematic risk would refer to those factors which affect the performance of the market as a whole such as inflation, interest rates, and the growth rate of the economy or stage of the business cycle. Systematic risk, because it affects the system as a whole, is not subject to diversification within the system. The second type of risk considered in the model, unsystematic risk, consists of factors affecting performance which are specific to any particular asset. For a particular stock, these might include demand for a key product, shortages of raw materials, sensitivity to local economic fluctuations, or any other factor which would affect that particular asset but not the market as a whole. This is the category of risk which can be mitigated through diversification.

Theoretically, assets can be picked which are not affected by the same unsystematic risks. Ideally, a perfect diversification should remove variability from the expected

return entirely by picking assets so that a downturn in one asset is exactly offset by an upturn in another asset in the portfolio. This condition, where one change is exactly offset by another opposite change, would be perfect negative correlation. In practice, lesser degrees of negative correlation are sought. Even uncorrelated changes, that is changes where the change in one asset return is not linked to the return changes in another portfolio asset, provide diversification benefit. What does not provide real diversification is when asset returns are affected by the same non-systematic factors, and thus display positively correlated changes in returns. That is, if all assets move in tandem, no real diversification has been achieved.

The benefits of diversification include lower volatility of returns and therefore greater predictability of the performance of a portfolio than of any single asset. By reducing the volatility, and hence the risk of the portfolio, returns can be estimated with more precision. The key to obtaining these benefits is to make sure that real, "scientific" diversification has occurred, and not "naive" diversification, where the portfolio appears to be diversified but in fact has assets which display significant correlations in their returns. A portfolio which appears to be diversified may not actually be so. This is particularly true in real estate, where diversification has typically been intuitive and naive.

Modern portfolio theory (MPT) is the application of the CAPM and a more recent but similar theory, the Arbitrage Pricing Theory (APT) to the construction of portfolios of assets which are provably scientifically diversified, with assets which are demonstrably negatively correlated or uncorrelated. In the securities markets this work is well advanced and has been proven. In real estate the work is less advanced, and faces several practical problems in full implementation. The first and most serious is the nature of the market. While the capital markets are widely assumed to be economically efficient markets, with homogeneous assets (shares), full availability of information at low cost and minimal transaction costs, real estate is by contrast an inefficient market of heterogeneous assets with very high transaction costs and very high information costs, when information is available at all.

Due to the lack of information and the lack of transactions, it is difficult to prove the correlation between different property types or regions. Studies done on the application of MPT to real estate have dealt with returns based on periodic appraisals of the properties, not on actual transactions. Because of the appraisal bias discussed earlier, these studies have understated the volatility of the returns. Because evaluation of correlation between assets depends on accurate measurements of the returns, the distorted return series make determination of correlations difficult.

Studies to date have attempted to present a format for scientific diversification of real estate. These studies have typically tested geographic hypotheses by taking appraisal-based return data from portfolios owned by institutional investors and constructing correlation matrices between regions, searching for regions which display negative or minimal correlations in the performance of properties within that location.

Real Estate Diversification

There are two possible type of diversification in real estate investment: property type and location. In theory, investors can mitigate the unsystematic risk of their portfolio without sacrificing return by diversifying among uncorrelated property types or geographic regions, that is those which are not subject to the same macro-economic variables. [10, p.25] Diversification by property type is based on the theory that performance of different property types is uncorrelated; that different property types are driven by different economic factors. Earlier studies of diversification by property type and geography supported the idea that property type diversification was the most cost effective form of risk reduction. [9, p.63] Later studies cast doubt on this theory, however. [6, 10] The economic characteristics which drive demand for real estate are typically driven by demographic and occupational shifts.

Within any given geographic market, the local economy and population is the primary demand determinant for all product types of real estate. Because of this factor, the market risk is a substantial factor, affecting all properties within that market. Given that substantially similar economic factors drive performance of all real estate within a market, it is not apparent that diversification by property type would provide uncorrelated returns among the property types, and that scientific diversification would be possible. That property type diversification has an effect seems certain, but the relative effectiveness of property type versus geographic diversification remains an unanswered question.

Geographic Diversification Models

Geographic diversification has historically been based on the intuitive notion that while similar economic factors drive each market and affect all properties within a single market, different markets will display different economic characteristics and display returns which are either uncorrelated or negatively correlated. Geographic diversification therefore offers the possibility of true scientific diversification, with uncorrelated return streams from each market combined into a portfolio of different markets with reduced risk. Geographic separation, however, does not guarantee uncorrelated performance. A more stringent analysis is necessary to determine whether

geographic areas are subject to the same macro-economic forces. [10, p.25] The key to such diversification is that each market should have its own unique set of driving economic factors. This led to the concept of economic location.

Economic location is the concept that from a portfolio point of view what matters in the evaluation of a property's location is not the actual geographic location but the driving forces in the local economy which produce demand for real estate. This concept provides a base for testing the geographic location of a property. A geographic region, in a meaningful portfolio sense, would be a region where properties were subject to the same economic forces affecting real estate supply and demand. Therefore, different regions would be driven by different economic factors. This would provide the possibility of a lack of performance correlation between regions, and would provide a theoretical basis for scientific geographic diversification of a real estate portfolio.

The initial models used for geographic diversification by the real estate industry were intuitive, not mathematical, and led to naive rather than scientific diversification. Typical of such naive diversification was a probably apocryphal Texas developer who stated he was diversified because he had assets in both Houston and Dallas. The model typically used by earlier researchers was a four-region model

of the United States, where the country was divided into four regions: the East, Midwest, West, and South. Tests of this model led to the conclusion that geographic diversification was not cost justified. [5, 7, 8] The conclusion was that this model did not provide a basis for scientific geographic diversification because it could not be shown that the regions were uncorrelated. All of these studies called for more exact models than the four-region model.

Other models for geographic diversification have since been proposed and tested. One of the most successful has been an eight-region model proposed by Hartzell, Shulman, and Wurtzebach (HSW). [6] This model attempted to "analyze the regional diversification issue by segmenting the country into eight regions based on similar underlying economic fundamentals." [6, p.85] It characterized the regions in terms of the driving forces of the local economy, and presented regions where real estate investment performance was driven by the same systematic factors. These regions were characterized as follows:

1. Northern California - includes northern California, northern Nevada, Oregon, and Washington.
2. Southern California - southern California, Arizona, southern Nevada, and Hawaii.

3. Mineral Extraction - from Louisiana, to Montana and including Alaska.
4. Farm Belt - the Great Plains.
5. Industrial Midwest - the Ohio and northern Mississippi valleys.
6. Old South - from Virginia south to Florida and west to Arkansas.
7. Mid-Atlantic Corridor - the Atlantic Coast from Fairfield County, Connecticut to northern Virginia.
8. New England - all New England states except Fairfield County, Connecticut.

The conclusions drawn from this model were based on the sample used by Miles and McCue [7, 8] and Hartzell, Hekman, and Miles [5] in their earlier studies. The conclusions differed markedly from the earlier studies. While the earlier studies found that performance of the four regions in that model were all significantly correlated, providing no opportunity for diversification, the eight-region model resulted in uncorrelated or negatively correlated returns among regions, providing the opportunity for true geographic diversification. The HSW model was the result of moving from a strictly geographic analysis to one based on economic fundamentals which underlie real estate performance. This

form of diversification calls into question the idea that scientific diversification by product type within a single region is possible. This is the model I will test with data from the REITs. This diversification model provided scientific diversification for the observed portfolio, using appraisal-based return series, which as noted above reduces the observed volatility of the returns by smoothing the return series. By using REITs to test the same model, I avoid the appraisal problem. I will evaluate REIT performance with respect to the observed diversification within this model to determine whether such diversification reduces the volatility of the returns, and thus whether the model provides a basis for scientific diversification for actual portfolios based on returns which are not affected by appraisal bias.

CHAPTER FOUR - METHODOLOGY AND DATA

Data Sources

The data used in this study came from publicly available reports such as REIT Annual and 10K reports. The REIT return data set was provided by Jun Han, Ph.D. from his doctoral dissertation research. The geographic diversification data and indices were compiled from a study of the 10K and Annual Reports for each REIT included in the sample.

Not all 10K reports listed acquisition and disposition periods by quarter. Where the data for actual acquisition dates did not exist, I assumed that properties were acquired at the start of each year. Similarly, for dispositions at an indeterminable date, I assumed that dispositions were made at the end of the previous year.

Model Tested

The model tested is the eight-region HSW model described in the previous section of this study. The geographic distribution of each portfolio was calculated on the basis of the acquisition cost of each property, plus any additional capital investment, less any financing. The resulting equity distributions represented the effective diversification of the equity in the portfolio. Depreciation was not considered in our analysis.

Measurement of Diversification

Raw Diversification Data - As noted above, the geographic distribution of the portfolio was tracked on a quarterly basis, and calculated on the basis of the total equity investment at a given point in time. I then divided each portfolio into the model's eight component regions and tracked the portfolio distribution from the first quarter of 1980 to the fourth quarter of 1989.

Concentration Index - I calculated the concentration index for each REIT for each time period by taking, for each of the eight zones of the model, the share S , squaring it, and then summing for all zones, according to the following equation:

$$CON = \sum_{z=1}^8 s^2; z = \text{zones}, s = \text{share}$$

This resulted in a concentration index of between 0.125, for a portfolio which was evenly distributed between the eight zones, and a concentration index of 1 for a portfolio concentrated in only one of the eight zones. The lower the concentration index, the better diversified the portfolio. In theory, the higher the concentration index, CON , the higher the variance will be. This is because the investors' utility function demands compensation for bearing a higher level of risk, and a less well diversified portfolio can be expected to display a higher level of risk in the form of return variance.

Sample Data

Subject REITs - my analysis was based on a representative subsample of equity REITs with data running from the first quarter of 1980 to the fourth quarter of 1989. I selected 11 of these REITs based on data availability, portfolio size, and the type of properties held.

Observed Diversification - the selected REITs range from those which are reasonably well diversified geographically, with no more than 23% in any one region and 15% or more in five of the eight regions, to the Washington REIT, which has all of its investments in one economic region. In most cases, as the portfolio evolved over time it became more diverse geographically. The notable exception to this is again the Washington REIT, which remained focused in the Washington DC area.

Variables Used

- 1) *Periodic Dummy Variables* - each period was given a dummy variable, 0 or 1, used to characterize the effect of time-related factors. This variable accounted for all exogenous factors occurring in a particular period.
- 2) *REIT Dummy Variables* - each REIT was given a dummy variable, 0 or 1, to account for any factors specific to that REIT.

- 3) S&P 500 Returns - periodic returns from the S&P500 were used to test for stock market influence.
- 4) Concentration Index - as discussed above, this index is a single number which represents the degree to which the portfolio is concentrated among the model's eight regions.
- 5) REIT Returns - the returns used were calculated for the periods observed and were not annualized. That is, the two period (five year) tests use returns observed over the entire five year period, not the average annual return.

I also used combinations of these variables. Each variable and combination will be further discussed in the next section of the analysis.

Time Periods Analyzed

Each of the three analytical methods uses several different observation periods. There are several reasons for this. Different effects may act over different time periods, and thus an effect which would not be significant over one time period may be so over a longer or shorter period. This is particularly apparent in the case of REIT data, where the amount of data can obscure meaning over shorter time periods but which may emerge in the long term.

Methodology

The analysis was conducted in three stages. First, the variance of the REIT returns was analyzed for one, two, and five-year periods. For the one year analysis, monthly returns were used. For the two and five-year analyses, quarterly returns were used. These variances were based on returns observed over the time period analyzed. That is, the variance for the two period (five year) analysis is based on the variance in observed returns over the entire five year period. I performed a multiple regression analysis using the variables listed above to determine which factors explained the variance.

Next, the returns are analyzed for their dependence on the variance, using the models used in the first section, with the variance substituted for the concentration index. According to the CAPM, a lower variance requires a lower return. This is because of the investors' utility functions, where lower risk requires a lower corresponding return to compensate for the risk. Therefore, if the variance is affected by the diversification of the underlying portfolio, then the returns observed should also be affected by the diversification, if the market is efficient. Again, the returns used represent the entire period of observation. This set of tests is to determine whether the CAPM assumptions hold - does variance affect returns? If in fact variance does affect returns, then returns should be affected

directly by any factors which affect the variance. If a factor affects variance, it should also affect the returns. Therefore if the concentration index affects variance it should also affect returns.

Finally, the actual returns of the REITs, from the entire observation periods, that is not annualized, were analyzed in a multiple regression analysis using the variables discussed above. This set of tests acts as an empirical check to determine whether or not the relationships derived in the first two sections hold in the real data.

Following the three analysis sections, there is a summary and conclusion section, where the results from the sections are analyzed and compared.

Variance Analysis

I used seven statistical models to analyze the relation of the diversification to the variance of the returns. Each analysis was made on periods of one, two, and five years. The one year periods are annually from 1980 to 1989. The two year periods are 1980-81, 1982-83, 1984-85, 1986-87, and 1988-89. The five year periods are from 1980-84 and 1985-89. For each period, the variance of the returns and the average concentration index were calculated. The models are described as follows. A summary and discussion of the results follows the descriptions of the models.

$$1) \quad V_{t,j} = \alpha + \beta D_t$$

This model examines the effect that time has on the variance of the returns, with each period t being given a dummy variable D_t to isolate effects due to that period.

$$2) \quad V_{t,j} = \alpha + \beta R_j$$

This model examines the effect that each REIT has on the variance of the returns, with each REIT j being given a dummy variable R_j to isolate its effects.

$$3) \quad V_{t,j} = \alpha + \beta CON_{t,j}$$

This model examines the effect that the concentration index $CON_{t,j}$ alone has on the variance of the returns.

$$4) \quad V_{t,j} = \alpha + \beta_1 D_t + \beta_2 R_j$$

This model combines the time effects using the dummy variable D_t for each period and the dummy variable R_j for each REIT.

$$5) \quad V_{t,j} = \alpha + \beta_1 CON_{t,j} + \beta_2 D_t$$

This model combines the concentration index with the time dummy variable.

$$6) \quad V_{t,j} = \alpha + \beta_1 CON_{t,j} + \beta_2 D_t + \beta_3 R_j$$

This model adds the REIT dummy variables to model 5, combining all elements of the variance analysis.

$$7) \quad V_{i,j} = \alpha + \beta_1 CON_{i,j} + \beta_2 R_j$$

This model is the concentration index and the REIT dummy variable.

Variance Analysis Summary

Periods	Model	R ²	Adjusted R ²	DIV _{t,j} t-stat.
2 periods	1: $V_{t,j} = \alpha + \beta D_t$	0.0043	-0.455	N/A
	2: $V_{t,j} = \alpha + \beta R_j$	0.6654	0.3611	N/A
	3: $V_{t,j} = \alpha + \beta CON_{t,j}$	0.0599	0.0129	1.1285
	4: $V_{t,j} = \alpha + \beta_1 D_t + \beta_2 R_j$	0.6697	0.3063	N/A
	5: $V_{t,j} = \alpha + \beta_1 CON_{t,j} + \beta_2 D_t$	0.0667	-0.0315	1.1272
	6: $V_{t,j} = \alpha + \beta_1 CON_{t,j} + \beta_2 D_t + \beta_3 R_j$	0.8263	0.5947	2.8485
	7: $V_{t,j} = \alpha + \beta_1 CON_{t,j} + \beta_2 R_j$	0.791	0.5611	2.4515
5 periods	1: $V_{t,j} = \alpha + \beta D_t$	0.123	0.05	N/A
	2: $V_{t,j} = \alpha + \beta R_j$	0.3174	0.1548	N/A
	3: $V_{t,j} = \alpha + \beta CON_{t,j}$	0.0209	0.0017	1.0429
	4: $V_{t,j} = \alpha + \beta_1 D_t + \beta_2 R_j$	0.4298	0.2197	N/A
	5: $V_{t,j} = \alpha + \beta_1 CON_{t,j} + \beta_2 D_t$	0.1463	0.0555	1.1327
	6: $V_{t,j} = \alpha + \beta_1 CON_{t,j} + \beta_2 D_t + \beta_3 R_j$	0.4513	0.2288	1.2044
	7: $V_{t,j} = \alpha + \beta_1 CON_{t,j} + \beta_2 R_j$	0.3245	0.1445	0.7026
10 periods	1: $V_{t,j} = \alpha + \beta D_t$	0.2189	0.1464	N/A
	2: $V_{t,j} = \alpha + \beta R_j$	0.2291	0.1488	N/A
	3: $V_{t,j} = \alpha + \beta CON_{t,j}$	0.0123	0.0029	1.1426
	4: $V_{t,j} = \alpha + \beta_1 D_t + \beta_2 R_j$	0.4437	0.3223	N/A
	5: $V_{t,j} = \alpha + \beta_1 CON_{t,j} + \beta_2 D_t$	0.2328	0.1529	1.3205
	6: $V_{t,j} = \alpha + \beta_1 CON_{t,j} + \beta_2 D_t + \beta_3 R_j$	0.4466	0.3178	0.6613
	7: $V_{t,j} = \alpha + \beta_1 CON_{t,j} + \beta_2 R_j$	0.2386	0.1505	1.089

Variance Analysis Results Discussion

The results of the models for the two-period test indicate that the concentration index, when combined with the time and REIT variables, explained a significant part of the variance of the returns. The adjusted R^2 of 0.5947 indicates that this model explains approximately 60% of the variance of the returns. The REIT dummy variables provided most of the explanatory power, explaining 36.11% of the variance. Time and diversification provided little explanatory power by themselves or combined, in models 1, 3, and 5, but when combined with the REIT dummy variables added to the explanatory power of the model. The concentration index provided most of this increase in explanatory power. Model 7, which combines the concentration index and the REIT dummy variables explained 56.11% of the return variance. Adding the time dummy variable to this, as in model 6, only explained an additional 3.36%. In model 6, the most powerful model, the t-statistic for the concentration index was 2.8485. This indicates that there is less than a 5% chance that the result is from chance, and provides strong support to conclude that the concentration index is a determining factor in the variance of the returns.

The five-period model yielded different results. For this set of models, the concentration index did not provide additional explanatory power, as demonstrated by comparing models 4 and 6. Model 4, which did not include the

concentration index, explained 21.97% of the variance while model 6, which is model 4 with the addition of the concentration index, explained 22.88% of the variance. The addition of the concentration index only explained an additional 0.91% of the variance, and in addition was not statistically significant, with a t-statistic of 1.2044. The five period model was much less successful in explaining the variance of the returns, with a maximum of 22.88% of the variance explained by the five period models, compared with 59.47% explained by the two period model.

The ten-period model was even less effective in explaining variance than the five period model. Comparing models 4 and 6, the concentration index actually decreased the explanatory power of the model from 32.23% to 31.78%, a decrease of 0.45%. Again, the time and REIT variables provided the most explanatory power.

Variance Analysis Conclusions

The concentration index did not provide statistically significant explanatory power in explaining the variance of the returns for the five and ten period analyses. For the two-period analysis, the concentration index explained 20% of the return variance in a statistically significant way. The two period analysis also resulted in the highest adjusted R^2 of all the analyses.

The noisiness of the return data makes shorter term results suspect, as discussed above. Model 6, the most successful of the models in all three periods used, has a steadily increasing t-statistic for the concentration index for longer periods, from $t=0.6613$ for the annual results, to $t=1.2044$ for the two-year results, and to $t=2.8485$ for the five-year results, which is statistically significant at a 95%+ confidence level.

The increasing adjusted R^2 and t-statistics as the length of the periods analyzed increases suggests that the effects of diversification are covered by noise in the data but emerge over time, as trends visible through the noise. The fact that diversification is statistically significant over a five year period suggests that it is in fact a genuine factor which contributes to the variance of the returns. The indicated coefficient has a positive sign. Since our concentration index is constructed so a higher value means a less diversified portfolio, this means that a less diversified portfolio would exhibit a higher variance in returns than a better diversified portfolio. This agrees with the idea that the HSW model provides a genuine basis for scientific geographic diversification.

According to the results of the model, the coefficient for the concentration index is positive for both analyses. The results of the model are presented in the following table.

Variance Analysis

2-period Model 6			
Variable	Coefficient	Concentrated	Diversified
Intercept	-0.0706		
CON	0.0794	1	0.125
D80-84	0.0041	1	1
DREIT1	0.0657	1	1
DREIT2	0.05	0	0
DREIT3	0.0573	0	0
DREIT4	0.0305	0	0
DREIT5	0.0624	0	0
DREIT6	0.0635	0	0
DREIT7	0.0603	0	0
DREIT8	0.0652	0	0
DREIT9	0.0476	0	0
DREIT10	0.0678	0	0
Calculated Variance		0.0786	0.0091
Calculated Std. Dev.		0.2804	0.0955
Eliminated Deviation		0.6593	

5-period Model 6			
Variable	Coefficient	Concentrated	Diversified
Intercept	-0.0157		
CON	0.0272	1	0.125
D80-81	0.0046	1	1
D82-83	0.0028	0	0
D84-85	-0.0101	0	0
D86-87	-0.0007	0	0
DREIT1	0.0365	1	1
DREIT2	0.0264	0	0
DREIT3	0.0209	0	0
DREIT4	0.0133	0	0
DREIT5	0.0183	0	0
DREIT6	0.0213	0	0
DREIT7	0.0208	0	0
DREIT8	0.0279	0	0
DREIT9	0.015	0	0
DREIT10	0.0259	0	0
Calculated Variance		0.0526	0.0288
Calculated Std. Dev.		0.2293	0.1697
Eliminated Deviation		0.2600	

For the five year periods, the calculated variance was 0.0786 for a fully concentrated portfolio and 0.0091 for a fully diversified portfolio. This is calculated over the

entire five year period, and is not annualized. This equates to standard deviations in portfolio returns of 0.2804 for a concentrated portfolio and 0.0955 for a diversified portfolio. Diversification has eliminated 18.49% of absolute standard deviation, or 65.93% of all deviational risk. The observed average variance for the REITs studied was 0.0167 for the first five year period, with an average concentration index of 0.3949 for that time period. Depending on the REIT selected from the model, the range of indicated variances is from 0 to 0.0351. The observed average variance is close to the middle of this range, indicating that the observed data supports the model.

For the two year period (the five period analysis), again calculated over the entire period, a portfolio which was fully concentrated, which would have a concentration index of 1, could be expected to have a variance of 0.0526, while a fully diversified portfolio, with a concentration index of 0.125, would have a variance of 0.0288. This equates to standard deviations in portfolio returns of 0.2293 for a concentrated portfolio and 0.1697 for a diversified portfolio. Diversification has eliminated 5.96% of absolute standard deviation, or 26.00% of all deviational risk. The observed average variance for the REITs studied was 0.0211 for the first two year period, with an average concentration index of 0.4273 for that time period. Depending on the REIT selected from the model, the range of indicated variances is from 0.0005 to 0.370. The observed average variance is close

to the center of this range, indicating that the observed data supports the model.

The results for the one year periods (the ten period analysis) were not statistically significant at even a low level of confidence, so I have not considered their effects here.

Given the context of the CAPM and investors' utility functions, we would expect that the variance of the returns must also explain the return of the security, because a reduced risk must be reflected in a lower return if the market is efficient. We therefore also examined the effect of the variance on REIT returns.

Return vs. Variance Analysis

I used seven statistical models to analyze the relation of the return variance to the average returns. Each analysis was made on periods of one, two, and five years. The one year periods are annually from 1980 to 1989. The two year periods are 1980-81, 1982-83, 1984-85, 1986-87, and 1988-89. The five year periods are from 1980-84 and 1985-89. For each period, the variance of the returns and the average returns were calculated based on the entire period, that is not annualized. The models are described as follows. A summary and discussion of the results follows the descriptions of the models.

$$1) \quad r_{AVG:t,j} = \alpha + \beta D_t$$

This model examines the effect that time has on the average returns, with each period t being given a dummy variable D_t to isolate effects due to that period.

$$2) \quad r_{AVG:t,j} = \alpha + \beta R_j$$

This model examines the effect that each REIT has on the average returns, with each REIT j being given a dummy variable R_j to isolate its effects.

$$3) \quad r_{AVG:t,j} = \alpha + \beta V_{t,j}$$

This model examines the effect that the variance, $V_{t,j}$ alone has on the average returns.

$$4) \quad r_{AVG:t,j} = \alpha + \beta_1 D_t + \beta_2 R_j$$

This model combines the time effects using the dummy variable D_t for each period and the dummy variable R_j for each REIT.

$$5) \quad r_{AVG:t,j} = \alpha + \beta_1 V_{t,j} + \beta_2 D_t$$

This model combines the concentration index with the time dummy variable.

$$6) \quad r_{AVG:t,j} = \alpha + \beta_1 V_{t,j} + \beta_2 D_t + \beta_3 R_j$$

This model adds the REIT dummy variables to model 5, combining all elements of the variance analysis.

$$7) \quad r_{AVG:t,j} = \alpha + \beta_1 V_{t,j} + \beta_2 R_j$$

This model is the variance and the REIT dummy variable.

Return vs. Variance Analysis Summary

Periods	Model	R ²	Adjusted R ²	r _{AVG:t,j} t-stat.
2 periods	1: $r_{AVG:t,j} = \alpha + \beta D_t$	0.4343	0.4060	N/A
	2: $r_{AVG:t,j} = \alpha + \beta R_j$	0.1829	-0.5599	N/A
	3: $r_{AVG:t,j} = \alpha + \beta V_{t,j}$	0.0093	-0.0402	0.434
	4: $r_{AVG:t,j} = \alpha + \beta_1 D_t + \beta_2 R_j$	0.6172	0.1961	N/A
	5: $r_{AVG:t,j} = \alpha + \beta_1 V_{t,j} + \beta_2 D_t$	0.4372	0.3779	0.3109
	6: $r_{AVG:t,j} = \alpha + \beta_1 V_{t,j} + \beta_2 D_t + \beta_3 R_j$	0.7117	0.3274	1.718
	7: $r_{AVG:t,j} = \alpha + \beta_1 V_{t,j} + \beta_2 R_j$	0.3274	-0.4124	1.466
5 periods	1: $r_{AVG:t,j} = \alpha + \beta D_t$	0.1911	0.1237	N/A
	2: $r_{AVG:t,j} = \alpha + \beta R_j$	0.1328	-0.0737	N/A
	3: $r_{AVG:t,j} = \alpha + \beta V_{t,j}$	0.0184	-0.0008	0.9791
	4: $r_{AVG:t,j} = \alpha + \beta_1 D_t + \beta_2 R_j$	0.3072	0.0519	N/A
	5: $r_{AVG:t,j} = \alpha + \beta_1 V_{t,j} + \beta_2 D_t$	0.1983	0.1131	0.6526
	6: $r_{AVG:t,j} = \alpha + \beta_1 V_{t,j} + \beta_2 D_t + \beta_3 R_j$	0.3366	0.0676	1.2808
	7: $r_{AVG:t,j} = \alpha + \beta_1 V_{t,j} + \beta_2 R_j$	0.1759	-0.0452	1.4648
10 periods	1: $r_{AVG:t,j} = \alpha + \beta D_t$	0.2248	0.1529	N/A
	2: $r_{AVG:t,j} = \alpha + \beta R_j$	0.0580	-0.0401	N/A
	3: $r_{AVG:t,j} = \alpha + \beta V_{t,j}$	0.0372	0.0281	2.0155
	4: $r_{AVG:t,j} = \alpha + \beta_1 D_t + \beta_2 R_j$	0.2825	0.1258	N/A
	5: $r_{AVG:t,j} = \alpha + \beta_1 V_{t,j} + \beta_2 D_t$	0.2354	0.1558	1.1544
	6: $r_{AVG:t,j} = \alpha + \beta_1 V_{t,j} + \beta_2 D_t + \beta_3 R_j$	0.3223	0.1647	2.2474
	7: $r_{AVG:t,j} = \alpha + \beta_1 V_{t,j} + \beta_2 R_j$	0.1391	0.0292	2.9265

Return vs. Variance Analysis Results Discussion

The statistical analyses summarized above indicate that the variance of the returns affects the actual level of the returns for the entire observation period in a statistically significant way for the ten period analysis, and at a 90% confidence level for the two period analysis. The significant two period result is consistent with what is expected from the earlier analyses in this report. The significant ten period result indicates that the effect operates in the short-term as well. Given that the variance is affected by diversification over longer time periods, and that the same tendency is apparent in the effect of the concentration index on returns, it was expected that variance, which was affected by diversification which in turn appeared to contribute to returns, would affect returns more visibly over longer time periods. This was the case, but the effect was also visible over one year periods. For different models, the change in period length has different effects; for model 5, the adjusted R^2 increases as the t-statistic for the variance drops as the period lengthens. For model 6, both the R^2 and t-statistic drop and then increase. For model 7, both the R^2 and t-statistic drop and then remain relatively unchanged.

The mixed results provide weak evidence that there is a link between variance and return in the long-term and short-term. The long-term result is consistent with the results in

the first section of this analysis. The short-term effect is evidence of a trend which is strong enough to be visible through the noise present in the data over the short-term.

According to the results of the model, the coefficient for the response of the returns to the variance is positive for both the two and five period analyses, 7.2268 for the two period analysis and 11.376 for the ten period analysis. This indicates that for a higher variance, a higher return is required, which is consistent with the assumptions of the CAPM and the investor utility function. We can use the model to calculate the difference in the required returns.

Return vs. Variance Analysis

2-period Model 6

Variable	Coefficient	Concentrated	Diversified
Intercept	0.0872		
Variance	7.2268	0.0786	0.0091
D80-84	0.1748	1	1
DREIT1	-0.2654	1	1
DREIT2	-0.308	0	0
DREIT3	-0.1231	0	0
DREIT4	-0.134	0	0
DREIT5	-0.077	0	0
DREIT6	-0.1788	0	0
DREIT7	-0.0394	0	0
DREIT8	-0.2352	0	0
DREIT9	0.0022	0	0
DREIT10	-0.1111	0	0
Calculated Required Return		0.5646	0.0624
Difference in Required Returns		0.8895	

The results for the two year periods (the five period analysis) were not statistically significant at even a low level of confidence, so I have not considered their effects here.

The ten period (one year) analysis was not significant for the variance, so I was unable to use the variances from that model to calculate required returns.

The results from my model indicate that a completely diversified REIT should only require a 6.24% return, while a completely concentrated REIT should require a 56.46% return. The average return for REITs over the comparable period, 1980-84, was 24.94%, while the average variance of returns was 0.0167. Given this average variance, the expected required return is in the range of 7.47% to 38.39%, depending on the REIT. When we compare this range with the range indicated by the model, they are close and indicate that the model has some consistency with reality.

Given that we can calculate the effects of the concentration index on the variance of the returns, and through the variance calculate the effect of the diversification on the returns of the REITs, it seems probable that if the market is efficient that there should be a statistically significant connection between the concentration index and the returns. I test this in the next section of the analysis.

REIT Return Analysis

To examine the effect of the concentration index on REIT returns, I used the variables discussed in that section of this paper to test nine statistical models. The analyses were made on the entire period of the analysis (1980Q1-1989Q4) on a quarterly basis, as well as on an annual and five-year basis. For each period, the returns and the concentration index were calculated. The models are described as follows. A summary and discussion of the results follows the descriptions of the models.

$$1) \quad r_{t,j} = \alpha + \beta D_t$$

This model examines the effect that time has on the returns, with each period t being given a dummy variable D_t to isolate effects due to that period.

$$2) \quad r_{t,j} = \alpha + \beta R_j$$

This model examines the effect that each REIT has on the variance of the returns, with each REIT j being given a dummy variable R_j to isolate its effects.

$$3) \quad r_{t,j} = \alpha + \beta CON_{t,j}$$

This model examines the effect that the concentration index $CON_{t,j}$ alone has on the returns.

$$4) \quad r_{t,j} = \alpha + \beta r_{S\&P500}$$

This model examines whether the S&P500 returns explain a significant part of the REIT returns.

$$5) \quad r_{t,j} = \alpha + \beta_1 D_t + \beta_2 R_j$$

This model combines the time effects using the dummy variable D_t for each period and the dummy variable R_j for each REIT.

$$6) \quad r_{t,j} = \alpha + \beta_1 r_{S\&P500} + \beta_2 R_j$$

This model combines the S&P500 returns with REIT dummy variables.

$$7) \quad r_{t,j} = \alpha + \beta_1 CON_{t,j} + \beta_2 D_t$$

This model combines the concentration index with the time dummy variable.

$$8) \quad r_{t,j} = \alpha + \beta_1 CON_{t,j} + \beta_2 D_t + \beta_3 R_j$$

This model adds the concentration index to model 5.

$$9) \quad r_{t,j} = \alpha + \beta_1 CON_{t,j} + \beta_2 r_{S\&P500} + \beta_3 R_j$$

This model adds the concentration index to model 6.

Quarterly REIT Return Analysis Summary

Variables	R ²	Adjusted R ²	CON _{t,j} t-stat.
Quarterly Dummy Variables	0.2911	0.2119	N/A
REIT Dummy Variables	0.0106	-0.0131	N/A
Concentration Indices	0.0017	-0.0007	0.9565
S&P500 Returns	0.1393	0.1373	N/A
Quarterly, REIT Dummy Variables	0.3015	0.2110	N/A
S&P500 Returns and REIT Variables	0.1500	0.1276	N/A
Concentration index, Quarterly Variables	0.2932	0.2202	1.174
Concentration index, Quarterly and REIT Variables	0.3018	0.2092	0.6572
S&P500 Returns, Concentration index, and REIT Variables	0.1505	0.1259	0.1038

Annual REIT Return Analysis Summary

Variables	R ²	Adjusted R ²	CON _{t,j} t-stat.
Annual Dummy Variables	0.2411	0.1729	N/A
REIT Dummy Variables	0.0575	-0.0377	N/A
Concentration Indices	0.0086	-0.0008	0.9565
S&P500 Returns	0.0258	0.0168	N/A
Annual, REIT Dummy Variables	0.2986	0.1506	N/A
S&P500 Returns and REIT Variables	0.0833	-0.0196	N/A
Concentration index, Annual Variables	0.2358	0.1562	1.174
Concentration index, Annual and REIT Variables	0.2861	0.1201	0.6572
S&P500 Returns, Concentration index, and REIT Variables	0.0792	-0.0383	0.1038

Five Year REIT Return Analysis Summary

Variables	R ²	Adjusted R ²	CON _{t,j} t-stat.
Period Dummy Variables	0.4774	0.4512	N/A
REIT Dummy Variables	0.1964	-0.5341	N/A
Concentration Indices	0.0191	-0.03	0.6234
S&P500 Returns	0.4774	0.4512	N/A
Period, REIT Dummy Variables	0.6738	0.3149	N/A
S&P500 Returns and REIT Variables	0.6738	0.3149	N/A
Concentration index, Period Variables	0.5122	0.4608	1.1639
Concentration index, Period and REIT Variables	0.7003	0.3007	0.8922
S&P500 Returns, Concentration index, and REIT Variables	0.7003	0.3007	0.8922

REIT Return Analysis Results Discussion

The results from the quarterly return series indicate that the quarterly dummy variables are the factor which explains most of the returns, with an adjusted R² of 0.2119. The S&P 500 returns have the second highest single factor adjusted R², of 0.1373, indicating that while stock market effects do influence the returns of REITs there are other time related factors as well. No other factors explain a significant part of the returns. The concentration index apparently does not explain returns on a quarterly basis, since when combined with the quarterly dummy variables it has an adjusted R² of 0.2202, an increase of only 0.0083 over the

time factor alone, at a statistically insignificant t statistic (95% confidence).

The results from the annual return series confirm the conclusions indicated by the quarterly return series, but provide even less explanatory power with much lower R²s. All indicated adjusted R²s were lower than for the quarterly return series. Again, the only significant factor was the time dummy variables, with an adjusted R² of 0.1729. The concentration index did not provide any additional explanatory power to the model, and in fact lowered the adjusted R² when combined with the annual dummy variables. Therefore, the concentration index does not provide any explanatory power for returns on either a quarterly or an annual basis.

The five-year return series (1980-84 and 1985-1989) display similar characteristics. The time variables and the S&P500 variables have identical effects. There are two interesting effects here. The first is that, like the variance analysis, the t-statistic for the concentration index increases from the annual to the five-year analysis for the full model with the concentration index, the time variables, and the REIT variables. While it is not statistically significant, in light of the results of the variance analysis it suggests that there may be a relationship which is obscured by the noise in the data, and

that for a longer observation period a statistically significant relationship might emerge.

The second interesting observation is the convergence of the S&P 500 and time R^2 s as the time period increases. Again, this suggests that over time, REIT returns tend to be affected by stock market factors. Short-term, other factors influence returns, but long-term returns are tied to those of the stock market.

REIT Return Analysis Conclusions

The results of our analysis indicate that of the factors we have identified and analyzed, only time provides significant explanatory power for REIT returns. The contribution of the concentration index to explaining the returns of REITs is not significant for any of the observed time periods. The increasing significance of the concentration index with increasing time periods, however, suggests that there is a relationship which is obscured by noise at shorter time periods. Given the relationships observed in the first two sections of the analysis, this appears likely. Tests using a data set which covers a longer period of time would allow this hypothesis to be tested, and are an area for future research.

CHAPTER FIVE - CONCLUSIONS

The first section of this report demonstrated that a concentration index, prepared based on the Hartzell-Shulman-Wurtzebach model, provided a statistically significant explanation for return variance. The second section demonstrated that there is a connection, although weaker, between variance and the total returns. The third section indicated, but not in a statistically significant way, that there may be a link between the concentration index and the level of returns.

In terms of the questions posed in Chapter 1, I have demonstrated in this analysis that, in the context of equity REITs and the Hartzell-Shulman-Wurtzebach model, that geographic diversification does explain the variance in returns in a statistically significant way over time periods of five years or more. The variance which was explained by the concentration of the portfolio also was demonstrated to influence returns, with higher variances requiring higher returns to compensate for the added risk. Also, diversification appears to affect returns themselves. Although this was not observed at a statistically significant level, the observations indicated that for longer time periods the t-statistic increased. Given the effect of diversification on the variance, which also exhibited increasing significance at longer time periods, it seems reasonable to assume in light of the existing observations

that the same relationship might hold. Verification requires further research.

The results of the research show that noise and other factors mask the effects of diversification in the short-term, but over time periods of five years or more diversification in the context of the HSW model significantly explains variance in returns and probably explains the returns themselves.

Using the results from sections one and two of the analysis, it is apparent that the concentration index, derived from the HSW model, has a real and substantial effect on variance, and that this effect carries through to the returns observed. Even though the direct link between the concentration index and returns is only weakly established and has not been demonstrated in a statistically significant way, the data from other sections of the analysis and the trends observed in that section indicate that such a direct link might exist, though proving so statistically requires further research.

Given my results, I have concluded that the HSW model of the real estate market provides a solid basis for genuine scientific diversification in real estate.

References

1. New York Institute of Finance, *Real Estate Investment Trusts: The Low Risk, High Yield, Asset Growth Opportunity*, New York Institute of Finance, 1988
2. Haight, G. Timothy and Ford, Deborah A., *REITs: new opportunities in real estate investment trust securities*, Probus Publishing Company, 1987
3. Jarchow, Stephen P., *Real Estate Investment Trusts: Tax, Securities, and Business Aspects*, John Wiley & Sons, Inc., 1988
4. Liu, Crocker H.; Hartzell, David J.; Grieg, Wylie; Grissom, Terry V.; "The Integration of the Real Estate Market and the Stock Market: Some Preliminary Evidence"; *Journal of Real Estate Finance and Economics*, 3:261-282 (1990)
5. Hartzell, David; Hekman, John; and Miles, Mike; "Diversification Categories in Investment Real Estate"; *AREUEA Journal*; Vol. 14, No. 2; 1986
6. Hartzell, David J.; Shulman, David G.; and Wurtzebach, Charles H.; "Refining the Analysis of Regional Diversification for Income Producing Real Estate"; *The Journal of Real Estate Research*, Winter 1987, pp.85-95
7. Miles, M. E.; McCue, T.E.; "Historic Returns and Institutional Real Estate Portfolios"; *AREUEA Journal*, Summer 1982
8. Miles, M. E.; McCue, T.E.; "Commercial Real Estate Returns"; *AREUEA Journal*, Fall 1984

9. Cole, Rebel; Guilkey, David; Miles, Mike; and Webb, Brian; "More Scientific Diversification for Commercial Real Estate"; *Real Estate Review*; 1987(?)
10. Firstenberg, Paul M.; Ross, Stephen A.; and Zisler, Randall C.; "Real Estate: The whole story"; *The Journal of Portfolio Management*; Spring 1988; pp.22-34
11. Zerbst, Robert H.; Cambon, Barbara R.; "Real Estate: Historical returns and risks"; *The Journal of Portfolio Management*; Spring 1984; pp.5-24
12. Gau, George W.; Wang, Ko; "A Further Examination of Appraisal Data and the Potential Bias in Real Estate Return Indexes"; *AREUEA Journal*; Vol. 18, No. 1, 1990; pp. 40-48
13. Giliberto, S. Michael; "Equity Real Estate Investment Trusts and Real Estate Returns"; *The Journal of Real Estate Research*; Vol. 5, No. 2 (Summer 1990); pp.259-263
14. Giliberto, S. Michael; *Equity Real Estate Investment Trusts and Portfolio Diversification*; New York: Salomon Brothers Inc., November 1989
15. Hartzell, David J.; Mengden, Anne E.; *Equity Real Estate Investment Trusts - Are They Stocks or Real Estate?*; New York: Salomon Brothers, Inc.; August 1986