IPF Joint Research Programme

Risk Reduction and Diversification in Property Portfolios – Literature Review

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Risk Reduction and Diversification in Property Portfolios: Literature Review

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The three-year programme supports the IPF's wider goals of enhancing the knowledge, understanding and efficiency of property as an investment class. The initiative provides the UK property investment market with the ability to deliver substantial, objective

and high quality analysis on a structured basis. It will enable the whole industry to engage with the other financial markets, wider business community and government on a range of complementary issues.

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Overview

Diversification is a key issue for many investors in commercial real estate. Individual property investments are relatively heterogeneous compared to equities and bonds and this means that specific risk can have a strong influence on their returns. Diversification can help reduce this specific risk. However, the indivisibility of property assets, causing large lot sizes and mutually exclusive ownership of such investments, makes the assembly of diversified portfolios difficult to achieve. Given this, it is critical for investors to know the suitability and effectiveness of their strategies to manage these risks within the context of their investment objectives.

In this study carried out by Investment Property Databank for the IPF, the characteristics of individual properties, real portfolios and simulated portfolios were examined in order to explore the degree to which different sized portfolios can reduce risk and are diversified. The study used a variety of techniques and a much larger pool of individual property data than previously analysed and this enabled the issues to be explored not only at the level of the whole market, but for different market segments and for individual years in order to understand changes through time and the impact of different market states.

Literature Review

The study comprises two reports; a main report setting out the context, methodology and results of the analysis and this companion report containing a detailed literature review. The main report is available from the IPF as a separate document.

Contents

1. Introduction

The questions and issues surrounding the topic of diversification have been the subject of much interest and research over the past few decades. This is because they are fundamental to investing – they concern how capital should best be invested, the interaction of risk and return and the effectiveness of investment strategies. The issues require investigation of individual asset characteristics, the nature and structure of investment markets and the relationship of different asset classes to one another. Research into diversification is therefore relevant to all investors, regardless of whether it is an explicit part of their strategy.

In this study, diversification is examined within the context of the commercial real estate market. The broader issues of diversification of a multi-asset portfolio are not examined directly, but the information here can inform asset allocation decisions and how they should be implemented[1]. The focus of this study is diversification within the real estate market itself. In particular, the questions of how difficult it is to diversify and how that varies in different sub-markets or different stages of the real estate cycle are addressed. This work, therefore, aims to build upon that of Brown (1988, 1991, and with Matysiak, 2000) and others in this area.

Much work has also taken place on the issue of what strategies might be adopted to assist diversification in the real estate sector. For instance, many studies in the UK, US and elsewhere have explored whether allocating funds across different property types may provide faster diversification than using regions or other criteria[2]. This issue is not tested in this study, but the examination of different sub-markets recognises that a distinct structure within the real estate market does exist. However, many previous studies have been conducted with aggregated data and the limited research so far on individual property data, together with low estimates of intra-property correlations (Brown and Schuck, 1996: 67), should encourage some caution in this regard. As Devaney and Lizieri (2005: 300) suggest, heterogeneity at the individual property level appears highly pervasive. The analysis of individual assets in this study could, therefore, shed more light on this issue and hence the question of structure and segmentation as a whole.

This study comprises two reports; a main report setting out the context, methodology and results of the analysis and this companion report containing a detailed literature review.

In this literature review, the principles of diversification are set out and research relevant to the study is reviewed. The report begins in Section 2 by outlining the seminal work and key concepts that underpin research in this area. This is then followed in Section 3 by an illustration of the measurement of risk reduction and diversification. Section 4 reviews research conducted in the equities market on these topics. This provides a useful comparison to the studies in commercial real estate that are then discussed in Section 5, several of which note key differences in the nature of property investments that prevent straightforward application of portfolio theory techniques. Finally, Section 6 outlines the aims and objectives of the IPF study given the body of previous work.

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[1] Summaries of research into the allocation for real estate within the multi-asset portfolio can be found in Hamelink and Hoesli (2004) and Seiler et al (1999).
[2] A summary of this work can be found in Hamelink et al (2000).

2. Principle of diversification

The intuitive idea of spreading capital over a number of different investments in order to reduce risk existed long before the development of modern portfolio analysis. However, the work of Markowitz (1952, 1959) enabled a formal framework to be developed within which portfolio risk and return, and hence diversification, could be analysed.

Markowitz showed that the expected return of a portfolio could be expressed as follows:

$$E(r_p) = \sum_{i=1}^{n} w_i E(r_i) \qquad \text{(Equation 1: Expected return of a portfolio)}$$

where $E(r_p)$ is the expected portfolio return, w_i is the proportion of funds invested in asset i and $E(r_i)$ is the expected return from the individual asset i.

However, while portfolio return is simply a function of the returns on individual assets and their weights, portfolio risk is more complex and depends on the variance in individual asset returns, their weights and the extent to which the returns of those assets move together, or co-vary. This can be expressed as follows:

$$\sigma_p^2 = \sum_{i=1}^{n} w_i^2 \sigma_i^2 + \sum_{i=1}^{n} \sum_{\substack{j=1 \\ j \neq i}}^{n} w_i w_j Cov_{ij} \qquad \text{(Equation 2: Risk of a portfolio)}$$

where σ_p^2 is the variance (risk) of portfolio returns, w_i is the proportion of funds invested in asset i, σ_i^2 is the variance of returns from asset i, w_j is the proportion of funds invested in asset j and Cov_{ij} is the covariance in the returns of assets i and j.

The covariance term can be calculated from information on the standard deviations of asset returns and the correlations between asset returns:

$$Cov_{ij} = \rho_{ij} \sigma_i \sigma_j \qquad \text{(Equation 3: Covariance within a portfolio)}$$

where ρ_{ij} is the correlation between the returns of assets i and j, σ_i is the standard deviation of the returns of asset i and σ_j is the standard deviation of the returns of asset j.

Note that while risk is classically measured by either the variance, or standard deviation in asset returns, there are a number of alternative definitions and measures also used in modern financial analysis, for which Booth et al (2002) provide a review.

From these relationships, Markowitz demonstrated that optimal portfolios could be calculated for a particular set of assets that minimised risk for a given level of return, or maximised return for a given level of risk. A rational investor would therefore select one of these optimal portfolios depending on their risk and return preferences.

At this stage, a more general relationship between the number of assets and portfolio risk may not be apparent. However, one can be derived if, for the moment, it is assumed that equal amounts are invested in each asset that enters the portfolio. The proportional weight of each asset is therefore 1/n, which means that equation 2 can be simplified and re-written as follows:

$$\sigma_p^2 = \frac{1}{n}\overline{\sigma}^2 + \frac{n-1}{n}\overline{\mathrm{cov}}_{ij}$$

(Equation 4: Relationship between portfolio risk and number of assets)

where σ_p^2 is the variance (risk) of portfolio returns, n is the number of assets in the portfolio, $\overline{\sigma}^2$ is the average asset variance and $\overline{\mathrm{cov}}_{ij}$ is the average covariance between portfolio assets.

This equation shows that total portfolio risk depends on the average variance of assets, the number of assets held and the average covariance between them. As the number of assets increases, the first term decreases and the second term increases as a proportion of total risk. Hence, as portfolios become larger, the impact of individual assets diminishes and the common relationship between the assets held becomes more important.

Before this can be related to diversification, though, another concept must be introduced, that of systematic and specific elements to risk. Systematic risk refers to volatility that is caused by factors that influence all assets in the market. Examples of this might be an improvement or deterioration in the economy, or changes in taxation or planning laws that affect the value of all commercial properties. Specific risk refers to volatility caused by events that affect only a single asset or subset of assets, such as the operation of a break clause, which would affect one individual property but not other property values.

These specific and systematic elements may appear to be represented by the separate terms in equation 4. Indeed, as the number of assets increases, it would be expected that asset specific factors will become less important and that the market will explain a rising proportion of overall portfolio risk. Furthermore, as *n* gets very large, the second term will tend towards the average covariance of all assets, which is the systematic risk level.

However, for different size portfolios, equation 4 does not measure these elements exactly. This is best illustrated by reference to a portfolio of just one property. In this case, there would be no other properties in the portfolio and so no covariance term, only variance in the returns of the property itself. As noted by Schuck and Brown (1997: 178-179), this would then imply that the risk of a single property is entirely specific risk. Yet some of the movement in its returns could still be due to general market influences.

The implication of this is that, while equation 4 can be used to measure portfolio risk and the reduction in that risk as the number of assets increases, it cannot provide an exact measure of diversification, because it does not precisely separate out specific and systematic risk. Diversification, in its strictest sense, is concerned only with the reduction of specific risk.

Definition:
Diversification is the reduction of specific risk in a portfolio.

Sharpe (1963) presented a way of modelling the behaviour of assets with respect to a single common (market) factor that has become known as the single index model. This presents the total returns on a single asset as follows:

$$r_i = \alpha_i + \beta_i r_m + \varepsilon_i \qquad \text{(Equation 5: Return on a single asset)}$$

where r_i is the return from individual asset i, r_m is the return of the market as a whole, α_i is a constant, β_i is the sensitivity of the returns of asset i to the market and ε_i is a random error term.

Individual returns are influenced by both the market (r_m) and by unique factors (ε_i), with the beta coefficient measuring the sensitivity of the asset to changes in market returns. The following expression can then be derived for the variance of returns:

$$\sigma_i^2 = \beta_i^2 \sigma_m^2 + \sigma_\varepsilon^2 \qquad \text{(Equation 6: Risk on a single asset)}$$

where σ_i^2 is the total variance of returns from asset i, σ_m^2 is the variance of market returns, $\beta_i^2 \sigma_m^2$ (together) represents the variability of asset i attributable to market (systematic) factors and σ_ε^2 represents the variability of asset i attributable to specific factors.

This expression shows that the risk of a single asset is a function of both systematic and specific factors. From this, the proportion of variance in returns that systematic and specific factors each represent can be calculated. Of particular interest is the ratio of systematic risk to total risk:

$$R^2 = \frac{\beta_i^2 \sigma_m^2}{\sigma_i^2}$$

(Equation 7: The proportion of total risk on a single asset explained by systematic risk

where R^2 is the ratio of systematic variance to total variance (and other symbols are as before).

This is the proportion of total variance or risk which is explained by the market and it can be estimated for either a single asset or a portfolio by regression of its returns against a market index. (R^2 is simply the square of the correlation coefficient). An increase in this ratio will conversely mean a reduction in the influence of specific risk and so it is an appropriate measure of diversification. Byrne and Lee (2003) document the equity market studies which first employed this ratio to measure diversification.

Again, a more general relationship with the number of assets held may not be apparent. However, Brown and Matysiak (2000: 338-339) show how this can be derived if, once again, it is assumed that equal amounts are invested in each asset, and that all assets possess the same uniform characteristics in terms of specific risk and covariance. Using their notation:

$$R^2 = \frac{nA}{nA + B}$$

(Equation 8: The proportion of portfolio risk explained by systematic risk)

where n is the number of assets within the portfolio, A represents systematic risk and B is the specific risk of a single asset[3].

Hence, as n increases, systematic risk becomes a larger component of total risk and the R^2 ratio rises. This formula can be used to find the typical diversification of a portfolio of any size, or be rearranged to find the number of assets needed for a given level of diversification (explanation).

Comment [KC1]: Is this an explanation of something, or is 'explanation' a synonym for diversification in this context?

It should be noted that, in deriving equations 4 and 8, the simplifying assumptions imply that investors diversify naively. Some investors may be able to forecast asset risks and returns, and so form a well diversified portfolio with fewer assets than these formulas suggest, ie undertake efficient rather than naïve diversification. It is also clear that such simplifications are not always realistic, and that particular assets may be very different from average. To tackle this, simulation of actual properties can complement the use of analytical techniques, with both approaches used in the investigations of this study (see main report).

Finally, it is helpful to consider why this measure of diversification has been developed and how the concepts of risk reduction and diversification outlined above relate to the strategies of investors.

The concept of diversification as the reduction of specific risk is related to the idea of forming optimal portfolios that was mentioned earlier. Sharpe (1964) argued that investors could find a better risk-return trade off if they combined investing in the 'market portfolio' with investing funds in the risk free asset. So, instead of selecting a combination of assets according to their return and risk preferences, the choice for a rational investor was how much to invest in the market and how much to lend or borrow at the risk free rate. This would then impact on the pricing of individual assets, for which Sharpe developed the Capital Asset Pricing Model. In theory, in an efficient market, an asset would only reward an investor for the extent to which it varied with the market, ie for its systematic risk, since that was the reason for which it was being purchased. Its returns would not reflect its specific risk.

It has, therefore, been argued that diversification is the process of reducing risk for which the investor is not properly compensated, rather than reducing risk outright. In practice, however, the assumptions of market efficiency that underlie this argument are often challenged, especially in the case of the commercial real estate market. So while some

[3] *A* can be computed as either the average covariance of all assets or as the variance of the market, since, for the whole market, the average β = 1. *B* can be found by subtracting *A* from the average variance of all assets.

investors aim for a high degree of market explanation in their returns, for many, this is a secondary consideration to that of identifying mispricing, either at the sector or asset level. Yet, amongst the latter group, there will be investors who desire a certain amount of risk reduction and for whom holding a portfolio has advantages over holding only one or two properties. This may particularly be the case for funds that wish to offer exposure to a sector or sub-sector, but who also try to provide their investors with excess returns from careful selection and active management of assets.

3. Illustration of risk reduction and diversification

In order to illustrate the points above and show how risk reduction and diversification can be measured, a brief example is now set out. This is useful for several reasons. First, it further highlights the distinction between the two concepts. Second, it shows how risk reduction and diversification are related, but are not identical. Third, illustration at this stage helps make sense of the seemingly conflicting messages from previous research in real estate, which has suggested that just a few properties bring great diversification benefits and yet hundreds of assets are required for a well diversified portfolio.

In Table 1, two scenarios are presented. In both scenarios, the risk of an individual asset, as measured by standard deviation of returns, is assumed to be 10% on average. In scenario 1, though, the average correlation between assets is much higher than it is in scenario 2. It is assumed that investment in assets takes place in equal amounts and that within each scenario the level of risk and correlation is uniform across assets. Portfolio risk for portfolios of one to 10 assets is then computed using equation 4, whilst the diversification of each portfolio size is computed using equation 8.

For scenario 1, the gains in risk reduction from building a portfolio are much smaller than in the case of scenario 2. However, the high correlations mean that assets are moving together in a similar way and this implies that systematic risk has more influence on their returns. Hence, it is easier to build a portfolio that is highly diversified – where market movement explains a lot of the variation in returns. In scenario 2, however, many more assets are needed before diversification approaches a similar level.

These findings hold whether or not individual asset risk is increased or decreased. In appendix 1, comparable tables are presented where the input standard deviation has been doubled. While the size of overall portfolio risk increases, the risk reduction and diversification profiles from adding more assets are identical.

From what has been discussed so far, the following points can therefore be made:

- The total amount of portfolio risk depends on both the variance and covariance of individual assets within the portfolio.
- The extent and speed of both risk reduction and diversification crucially depend on the covariance (correlation) among assets.
- Low average correlations among assets in a market present much scope for risk reduction, but it will be difficult to construct highly diversified portfolios.
- High levels of correlation may mean less risk reduction in absolute terms, but diversification will be easier, owing to the greater role of systematic factors in explaining returns.

These points should not only be true under the idealised conditions of the illustration, but will also apply for the empirical investigation in the main report, which uses real data on property investments, without assumptions of uniform characteristics or equal lot sizes and weightings.

Table 1: Risk Reduction and Diversification illustrated with Hypothetical Data

	Scenario 1		Scenario 2	
Standard deviation	10		10	
Correlation	0.9		0.2	
Variance	100	= A+B	100	= A+B
Co-variance	90	= A	20	= A

No of assets	Scenario 1: Variance (risk)	Scenario 1: Standard deviation	Scenario 1: % fall in standard deviation	Scenario 1: Diversification[4]	Scenario 2: Variance (risk)	Scenario 2: Standard deviation	Scenario 2: % fall in standard deviation	Scenario 2: Diversification
1	100	10.0		90%	100	10.0		20%
2	95	9.7	3%	95%	60	7.7	23%	33%
3	93	9.7	3%	96%	47	6.8	32%	43%
4	93	9.6	4%	97%	40	6.3	37%	50%
5	92	9.6	4%	98%	36	6.0	40%	56%
6	92	9.6	4%	98%	33	5.8	42%	60%
7	91	9.6	4%	98%	31	5.6	44%	64%
8	91	9.6	4%	99%	30	5.5	45%	67%
9	91	9.5	5%	99%	29	5.4	46%	69%
10	91	9.5	5%	99%	28	5.3	47%	71%

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[4] Earlier, it was stated that R^2 was the square of the correlation coefficient, ρ. Under these special assumptions, however, this does not hold for the one asset portfolio, where R^2 and ρ are, in fact, equal – see Brown and Matysiak (2000: 354).

4. Review of prior research: equity markets

Although the principles outlined so far can be related to other assets and markets, it is in the context of the equity market where this framework was developed. It is, therefore, not surprising that the first empirical studies of this topic were also in the equity market, with replication in other markets occurring later. While this report focuses on commercial real estate, a brief review of some of the important equity market studies is appropriate, since these form a foundation for subsequent real estate research. Their findings can also be usefully compared to the real estate results to highlight the differences between the two asset classes, and show how investment in each market might be approached and understood.

Evans and Archer (1968) is the earliest empirical study usually cited in this area. Using data on individual shares within the US S&P 500 index, they constructed portfolios from one to 40 stocks in size through random selection. This process was repeated 60 times, and the average standard deviation of each set of portfolios was measured. A risk reduction profile was then created, which took the form of a declining asymptotic function. This, the authors noted, meant that risk reduction was ultimately bounded by the systematic risk of the market. They then observed that most risk reduction was achieved by the time eight stocks were selected and concluded that investors should consider marginal benefits when adding more stocks to their portfolio, which beyond 10 stocks may not be very great.

Following this, several other simulation studies were then conducted. Elton and Gruber (1977), however, made an important step forward by developing analytical solutions to the risk reduction question. Although their focus was on deriving general expressions from which the size-risk relationship could be measured, they demonstrated the use of these on individual share data from the New York and American Stock Exchanges. The average variance and covariance of all the shares was measured and reductions in risk were estimated. It was again observed that most risk reduction was achieved by the time 10 to 20 stocks were in the portfolio, but Elton and Gruber argued that very large portfolios could still show significant gains in risk reduction over smaller counterparts.

The question of how many stocks should be held for diversification was then revisited by Statman (1987). Although prior work had noted that marginal benefits and costs should be considered, figures such as 10 stocks had been suggested simply from examination of risk reduction profiles. Statman, therefore, presented a framework where the gain in return from holding a large portfolio was set against the loss in return from transaction and management costs. The idea that a gain could be realised was based on the ideas of Sharpe (1964) set out above; for a certain amount of risk, an investor could either hold a small portfolio or invest in a large (market) portfolio with a combination of their own and borrowed funds. In Capital Market Theory, the latter would yield a higher return, in which case the decision to diversify should depend on whether or not the cost of this choice was greater than the added performance.

Hence, Statman (1987) compared the return and volatility of portfolios of different sizes with the implied return from investing in an index fund and borrowing to achieve the same volatility. Set against the excess returns from the index strategy were the costs of holding units in the index fund, which causes a slight underperformance of the (S&P 500) index itself. He found that, up to 30 to 40 stocks, the benefits from the large portfolio outweighed the further costs, but beyond that, they were too small. It was noted that the assumptions of the study may mean that 30 to 40 was still an under-estimate.

Such estimates are, of course, dependent in part on the time frame and equity market being considered. Nonetheless, the evidence suggests that tens rather than hundreds of shares provide adequate diversification for most investors, and the characteristics of equity investment make such a target attainable.

5. Prior research in and application to real estate

When applying portfolio theory to an actual asset market, real world factors, such as transaction costs, and the particular characteristics of that market must be taken into account. This is especially true in the case of commercial real estate. An investor in real estate faces a number of issues that may cause investment strategy to be frustrated. For risk reduction and diversification, key issues are the large lot size of properties, making assembly of large portfolios expensive, and their indivisibility, causing an uneven distribution of values within the portfolio. Other important investment issues are illiquidity and the need for practical management of properties, although the latter may also present opportunities.

These issues do not mean that the insights and techniques of investment theory cannot be applied at all, though. The pursuit of diversification may still bring great benefits to real estate investors, and research in this area can increase knowledge of the nature of property as an investment and asset class. This section reviews previous work on risk reduction and diversification in commercial real estate, concentrating on those studies that have been carried out in the UK real estate market.

Several early studies adopted the approach of Evans and Archer (1968) in the equity market to analyse risk reduction as real estate portfolios increased in size. This involved simulating portfolios of different sizes and measuring the volatility of their returns. From such exercises, JLW (1986) concluded that most of the possible risk reduction had been achieved by the time 20 properties were in the portfolio, while Barber (1991) judged that this was true once 40 to 45 properties were included. However, these figures did not mean that high levels of diversification had been attained, as this aspect was not addressed. Nor did they necessarily translate to individual experiences or to the observed behaviour of funds, as later research demonstrated.

The first major study of both risk reduction and diversification was published by Brown (1988). He primarily relied on analytical techniques, using a small number of simulations in a supporting role. From monthly returns data on 135 properties, Brown also showed that most risk reduction could be achieved rapidly; by the time 10 properties were in a portfolio. This was because of low correlations between individual assets, even between assets in the same sector. Yet the same factor meant that high levels of diversification were very difficult to achieve. He reported that, on average, the market (entire sample) only explained 10% of the return variation of individual properties, compared to 30% in the case of UK equities (1988: 144)[5]. This indicates that the influence of specific risk on individual commercial property investments is large and proportionally much greater than in the case of shares. Brown then estimated that 200 properties would be needed for the market to explain more than 95% of real estate portfolio returns (1988: 145).

These findings have important implications. They suggest that many actual real estate portfolios might be poorly diversified, though it should be noted that diversification is not necessarily a major objective for each one. This is despite potentially major reductions in risk over that of holding just one asset. Specific risk may continue to have a major impact even on the returns of large property portfolios. Also, as Brown noted (1988: 146), it will be difficult for real estate portfolios to track a market index, and two funds

[5] It is not clear whether Brown derived the comparison figure himself or obtained it from another source.

structured in seemingly similar ways may perform very differently from each other. Brown and Schuck (1996) then suggest that these difficulties of diversifying within real estate may help explain low allocations to the sector in the multi-asset portfolio.

These analytical results were derived using the assumption that equal amounts could be invested in different properties. However, the simulations of Brown (1988), conducted on a value-weighted basis, indicated that uneven lot sizes could have an important influence on the results. The first work to thoroughly investigate this issue was that of Morrell (1993). Morrell not only researched the difference that value-weighting might make to the diversification of real estate portfolios, but he also highlighted that equal-weighting is not a realistic choice for real estate investors. Properties come in different sizes and they are generally indivisible, which means it is practically impossible to construct an evenly weighted portfolio. Nor is equal-weighting necessarily a desirable strategy. Large lot sizes characterise certain segments of the market, such as City Offices and Shopping Centres. To not invest in these assets on the grounds that the portfolio would become unbalanced would also mean that important areas of the market were being excluded, itself undesirable if diversification is an aim.

Morrell (1993) therefore empirically tested the influence that unequal weight has on the dispersion of returns. To do this, he used cashflow data for 562 individual properties held over the period 1984-1987. This data enabled the calculation of both equal-weighted and value-weighted portfolio returns to be made. Portfolios of sizes two to 50 properties were constructed using random selection, with 100 created for each size within each year. Morrell found that the dispersion of value-weighted returns was significantly greater than that of equal-weighted returns. Hence, uneven lot sizes contribute to portfolio risk, as they mean that even seemingly large portfolios can be dominated by just one or a few assets, creating quite different return outcomes. This result also implied that previous estimates of the number of properties needed for risk reduction or diversification were underestimates, with more needed to counter this lot-size effect.

However, the exact relationships between the number of assets, uneven lot sizes and levels of specific and systematic risk are complex, as can be seen from the discussion in Schuck and Brown (1997). While uneven lot sizes may, on average, add to portfolio specific risk, the actual impact depends on individual asset risks, the degree of value skewness and the correlations between the assets involved. In individual cases, value-weighting may even lead to portfolios exhibiting lower volatility than their equal weighted counterparts, depending on the assets concerned. In general, Schuck and Brown found that value weighting has more impact where correlations between assets are low (1997: 180-1), which, for UK commercial real estate, appears to be the case.

Morrell (1993: 169) also noted that the indivisibility of real estate assets meant that direct investment in each was exclusive. Therefore, real estate portfolios contain discrete sets of assets, in contrast to equity portfolios, which may hold shares of the same companies. This is a more fundamental reason why real estate portfolios cannot track an index than the low correlations noted earlier. It also means that risk-return characteristics at an index level are unlikely to be experienced by individual real estate portfolios. In a later paper, Morrell (1997) shows how this might impact on the multi-asset portfolio decision. He also suggests that the inability to cross-invest in different properties is behind the efforts of investors to identify homogenous segments or groups of assets by which they can structure investment (1997: 10). A key question then for investors is how many properties are needed within these groups to provide a reasonable proxy of their risk and return characteristics.

Individual experiences and diversification across segments are two themes also explored by Byrne and Lee (2000). They used analytical techniques to produce evidence on risk reduction, but argued that simulation enabled a number of further issues to be studied; the range of risk reduction outcomes, equal- vs. value-weighted experiences, and whether sampling with or without replacement had a major influence on results. One drawback of this study was that partially aggregated data was utilised[6]. However, the authors were able to show that previous studies which presented average risk reduction profiles may have been misleading. While average variance is significantly reduced by the time 20 properties are held in a portfolio, individual outcomes vary widely, with some portfolios still highly exposed to specific risk. Reducing variance in variance may, therefore, justify larger portfolios, with the simulations indicating significant falls in this aspect up until the inclusion of 60 to 80 assets within the portfolio.

Further evidence on risk reduction in UK commercial real estate has been provided by Brown and Matysiak (2000). They updated the work of Brown (1988) using return data provided by IPD for anonymised individual properties. From two samples with monthly returns, covering the periods Dec-87 to Nov-92 and Dec-92 to Nov-97 respectively, the authors obtained similar risk reduction profiles to those found in the 1988 research (see pp. 324-9). The different periods analysed allowed some comment on the possible influence of market state, with slightly higher correlations between properties and less potential risk reduction in the volatile period of 1987-1992. Analysis of a separate sample of 750 properties with annual returns, though, produced markedly different results. Here, average correlations were of the order of 0.4, compared to 0.1 from the monthly data. This then raises the issue of return measurement frequency. If annual returns are to be preferred, then these results suggest that systematic factors are more important in real estate and the potential for risk reduction is less than previously thought.

Finally, though not directly related to this investigation, it is useful to comment on those studies that have analysed the experiences of actual real estate funds. It was observed by Cullen (1991) that the volatility in returns of portfolios monitored by IPD did not seem to decrease as fund size increased, despite all that has been said above. Indeed, some very small portfolios could show very low levels of risk given the number of properties held. Explanations offered as to why this should be the case included the impact of uneven lot sizes (Morrell, 1993; 1997), the existence of differential forecasting skill (Schuck and Brown, 1997: 174) and the influence of active management (Schuck and Brown, 1997: 184). However, the comprehensive study by Byrne and Lee (2003) showed that this is likely to be caused by differences in the character of large funds. They found that total volatility increased as funds got larger, but that diversification (market explanation) increased as well. Specific risk, therefore, was being reduced, but the large funds carried more systematic risk. This resulted from their being better able to access all segments of the real estate market.

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[6] The returns and values of locations within the IPD *Local Markets Report* of that year.

6. Aims and objectives of this study

It can be seen from this literature review that the issues surrounding diversification and risk reduction have often been of interest to researchers, mirroring their practical significance for investors in equities and commercial real estate alike as they seek to devise and implement appropriate investment strategies. The literature on commercial real estate in particular, however, highlights several features of this market that make diversification difficult and which have led researchers to periodically re-examine its possibility; for instance, the indivisibility of properties which creates large and uneven lot sizes (making weighting choices difficult) and which mean that no investor can hold a stake in each asset and hence replicate an index.

In addition to these characteristics, though, previous real estate research has often not had access to detailed individual level data on a large sample of assets, required for formulating more definitive answers to both basic and complex questions alike. This is in stark contrast to the situation in financial markets, where data is public, of high frequency and exists over long time periods.

Therefore, this IPF study seeks to advance previous research by applying a number of techniques, both analytical and simulation-based, to the large database of individual UK property performance data held by IPD for the exploration of a wide range of issues, including:

- The basic characteristics of individual assets in terms of risk and correlation.
- The risk of actual funds (both balanced and specialist) of varying sizes that are monitored by IPD.
- Risk reduction profiles based on individual assets, rather than aggregated data – to quantify the change in risk as property portfolio size increases.
- Differences in risk reduction possibilities between different segments of the real estate market.
- Differences between individual years, in order to examine the changing nature of risk through time and the impact of different market states on risk and investment strategy.
- The measurement of risk reduction and diversification as portfolio size increases, through a time-series analysis using a held sample of properties.

The empirical investigation that addresses these many questions is contained within the main IPF report. However, although this review is published separately, it has been integral to the development of the research. It has aimed to set out the main principles and analytical issues to be considered in conducting a study in this area. By reviewing the strengths, limitations and results of previous research, it has also aimed to provide a benchmark against which the approach and results of the main report can be assessed.

Literature review: Summary

- *The topics of risk reduction and diversification have attracted much research in the last few decades, as they concern how capital should best be invested.*
- *This report examines diversification within the commercial real estate market.*
- *The work of Markowitz (1952, 1959) and Sharpe (1963, 1964) has helped create a formal framework within which portfolio risk and return, and hence diversification, can be understood.*
- *An important distinction is that between systematic and specific risk:*
    - *Systematic risk relates to factors that affect all assets within a market.*
    - *Specific risk relates to events that influence individual asset performance or that of particular groups of assets.*
- *While risk reduction relates to reducing volatility in investment returns, diversification relates to the reduction of asset specific risk and to achieving a greater amount of market explanation of returns.*
- *The potential for risk reduction and diversification are both crucially affected by the degree of co-movement between assets in a particular market.*
- *In the real estate market, low correlations mean that much risk reduction may be achieved through holding only a few properties, but a very large number of properties are required to be highly diversified.*
- *In addition, factors such as indivisibility and uneven lot sizes pose further difficulties for portfolio construction. Their impact can mean that even large portfolios continue to be strongly influenced by property specific risks.*
- *In this study, a much larger pool of individual property data than that analysed before is utilised to examine the following:*
    - *What are the characteristics of individual assets and how do these affect risk reduction and diversification?*
    - *How do prospects for risk reduction and diversification vary:*
        - *In different sub-markets*
        - *Through time and in different market states?*

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Appendix 1: Risk Reduction and Diversification in Different Scenarios – using Hypothetical Data

An additional example of risk reduction and diversification where individual asset risk has been doubled to 20%.
See pages 9-10 for discussion.

	Scenario 1				Scenario 2			
Standard deviation	20				20			
Correlation	0.9				0.2			
Variance	400	= A+B			400	= A+B		
Co-variance	360	= A			80	= A		
No of assets	**Variance (risk)**	**Standard deviation**	**% fall in standard deviation**	**Diversification**	**Variance (risk)**	**Standard deviation**	**% fall in Standard deviation**	**Diversification**
1	400	20.0		90%	400	20.0		20%
2	380	19.5	3%	95%	240	15.5	23%	33%
3	373	19.3	3%	96%	187	13.7	32%	43%
4	370	19.2	4%	97%	160	12.6	37%	50%
5	368	19.2	4%	98%	144	12.0	40%	56%
6	367	19.1	4%	98%	133	11.5	42%	60%
7	366	19.1	4%	98%	126	11.2	44%	64%
8	365	19.1	4%	99%	120	11.0	45%	67%
9	364	19.1	5%	99%	116	10.7	46%	69%
10	364	19.1	5%	99%	112	10.6	47%	71%