Basis Risk and Property Derivative Hedging in the UK:

Implications of the 2007 IPF Study of Tracking Error

By

Jia Ma

Master of Architecture, 2004, Tsinghua University

Bachelor of Architecture, 2001, Tsinghua University

Submitted to the Center for Real Estate in Partial Fulfillment of the Requirements for the Degree of Master of Science in Real Estate Development at the Massachusetts Institute of Technology

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Abstract

This thesis examines how the basis risk affects property derivative hedging in the UK market, based on the tracking error (basis risk) report from the Investment Property Forum study in 2007 (the IPF Study). The thesis first analyzes the risks relevant to hedging and defines the basis risk. Considering hedgers with different objectives measure hedging efficiency differently, this thesis divides the hedging users into two major categories: *β-Avoidance* hedgers and *α-Usage* hedgers. Each of these has two sub-ordinate groups. In order to quantify the basis-risk influences on hedging, a Monte Carlo simulation designed for short contract of the swap is used. Basis risks of portfolios with different sizes are selected from the IPF Study. To shed light on different hedging uses, three scenarios are tested based on different assumptions on the expected alpha and leverage. Other relevant elements are also studied, such as the price of the debt and the swap. The analysis results in a useful reference for investors who are interested in eliminating portfolio risks with hedging strategies. In the end, the thesis suggests avenues for the further study.

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Chapter 1: Introduction and Background Knowledge

1.1. Introduction

Real estate derivatives have existed in the UK market since early 90's and have experienced a fairly fast development during the past five years. As a proxy of the real estate market, the property derivative replicates characteristics of physical properties and attracts investors for two reasons. First, it offers efficient transactions to investors, making it possible to increase real estate exposure without suffering the high cost of holding physical properties. Second, it facilitates risk management for asset managers, allowing the adjustment of property portfolios as quickly as the market changes. In the past market boom, numerous investors rushed into the real estate market and underestimated the potential risks associated with properties. The recent market downturn, however, gives rise to the attention to manage risks underlying properties. Property derivatives, as a potential way to take away the real estate market risk, are inducing more and more interests of investors.

Investors have more than considerations for hedging with property derivatives. The primary consideration is the basis risk, that is, the difference of return between property portfolios and the index. The basis risk makes it difficult to hedge property risks accurately and efficiently.

How much basis risk the hedgers have to take and how the basis risk influences the hedging are the critical questions to be answered.

The study "Risk Reduction and Diversification in Property Portfolios Main Report"[1] from Investment Property Forum (IPF)[2] in 2007 reports the basis risks, or "tracking errors,"[3] of different sized portfolios in the UK market. The portfolios tested in the IPF study were randomly selected, using Monte Carlo simulation from the Investment Property Databank (IPD)[4] property data from 1994-2004. By calculating the return and volatility of 20,000 hypothetical portfolios benchmarked on the IPD Index, the IPF study provides an explicit answer for the first question as mentioned earlier: how much basis risks are portfolios subject to based on different portfolio sizes.

To extend the IPF study, this thesis explores the answer of the second question: How does basis risk influence the hedging result? To do so, three steps are employed in sequence. In the first step, the thesis points out the two major risks relevant to hedging: basis risk and sub-market risk, and analyzes the definition of basis risk in depth. Second, the thesis divides hedgers with

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[1] Mark Callender, et al.,"Risk Reduction and Diversification in Property Portfolios Main Report." Investment Property Forum, May 2007

[2] IPF: Investment Property Forum. Website: http://www.ipf.org.uk/

[3] Tracking error is a measure of how closely a portfolio follows the index to which it is benchmarked. It is the same concept as the basis risk in this thesis.

[4] IPD: Investment Property Databank. Website: http://www.ipd.com/

different objectives into two main categories: β- Avoidance hedgers and α -Usage hedgers, and then illustrates the four sub-ordinate uses by examples.

The third part of the thesis quantifies how much the basis risk could affect hedging and analyses how hedgers take into account of basis risks. A Monte Carlo simulation for the swap[5] is used to examine the effect of basis risks to different hedging uses. Basis risks of portfolios with 3, 5, 10, 20, 50, 100, and 500 properties are selected from the IPF study and are tested in the simulation. The two fundamental hedging uses are represented by three scenarios with different assumptions on the alpha expectation and leverage ratio. To simulate the real world, the price of derivatives and that of debts are counted in each of the three scenarios. Three measurements of hedging reflect the results of the simulation analysis: the *ex post* return, the return volatility, and the realized alpha. Finally, by analyzing the results of the simulation, the thesis summarizes the effects of the basis risks on hedging and suggests the scope of further studies.

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[5] A swap refers to a derivative in which two parties agree to exchange one stream of cash flows against another. It is the major property derivative traded in current market.

1.2. The Background Knowledge about Property Derivatives

Over the past twenty years, property derivatives have been increasingly used by institutional investors in the UK market. The property derivatives is attracting notices as not only an efficient investment product but also a potential hedging vehicle. By presenting necessary background knowledge, this section will help readers understand the advantages and impediments of commercial property derivatives as a risk management method.

(1) *The Definition of Property Derivative*

Broadly defined, a property derivative is a signed contract that derives its value from an underlying property index. Another definition is: "Any synthetic product that has its ultimate price or payout determined by an underlying index performance or number." This includes swaps based on a notional value as well as structured products that involve a principle payment.[6]

[6] Jani Venter, "Barriers to Growth in the US Real Estate Derivatives Market." MSRED Thesis, 2007.

（2） *Derivative Product and Market*

Three main derivative products trade in the global market: *swaps*, *options*, and *structured notes*. The major contracts traded in the current market are swaps, including *total return swaps* and *capital return swaps*. In addition to swaps, small amount of options and structured notes are traded in the UK market. Most derivatives, such as swaps and options do not require upfront cash flow. However, structured notes need an immediate down payment to the intermediary and are limited to institutional investors with high credibility.

Currently, most of the property derivative transactions occur on the broadly aggregated IPD all-property index in the UK market. Although the IPD produces developed sub-sector indices in terms of property types and segments, the transaction based on sub-sector index is still sparse. With the gradual maturing of the derivative market, more trades will happen in sub-sectors to meet the requirement of specific physical portfolio holdings.

(3) *The Advantages of the Property Derivative*

By replicating characteristics of physical properties, the property derivative can be a plus for real estate investors in both direct investment and risk management. The comparison between the property derivative and the other forms of real estate investment is shown in Table 1-1.[7]

Table 1-1: How Property Derivatives Compare to Other Forms of Real Estate

Rating: 1-Poor;2–Below average; 3–Average; 4–Above average; 5-Excellent

	Direct	**Indirect (ex-REITS)**	**REITS**	**Derivatives**
Transaction costs	1	1	5	5
Low ongoing annual administration cost	1	2	4	5
Ability to hedge	1	1	2	5
Risk management tool	1	1	1	5
Diversification	3	4	4	5
Liquidity	1	2	4	4
Pricing transparency	2	3	5	5
Pure property exposure	5	4	3	5
Volatility relative to direct		3	1	5
Time to execute	1	2	4	4
Size of transactions	5	4	4	3
Tenor of transactions	5	4	4	3
Flexibility & structure	3	3	3	5
Marking to market	3	3	5	5
Manager alignment for investors	5	3	3	4
Credit risk	4	3	2	3
Alpha generation	3	3	3	3
Global exposure	2	3	3	5

[7] Philip Ljubic, "Property Synthetics." The Royal Bank of Scotland, January 2009.

Table 1-1 shows the most obvious advantage for the property derivative is its low cost and high flexibility. The traditional forms of property are burdened with high costs, including transaction fees, relevant taxes, and operational expenses. In addition, the physical property transaction takes a long time, adding considerable opportunity cost. In the UK, the cost of owning physical properties is estimated as about 300 to 500 basis points per annum above the prevailing benchmark interest rate (UK LIBOR[8]).[9] Property derivatives provide an economical way to solve problems for investors. They allow efficient investment on the real estate with much less cost.

Another noticeable advantage of property derivatives is to manage risk by hedging. Without property derivatives, there is no way to reduce property market risk without selling the property. The high cost of property transactions makes it difficult to adjust property risks quickly and efficiently. By using short derivative contracts underlying properties, investors can hedge away the property market risk and lock the value created on the properties. This study only focuses on the short hedging and thus does not pursue much on the long derivative contracts. Section 1.3 illustrates more details on issues in hedging with the property derivative.

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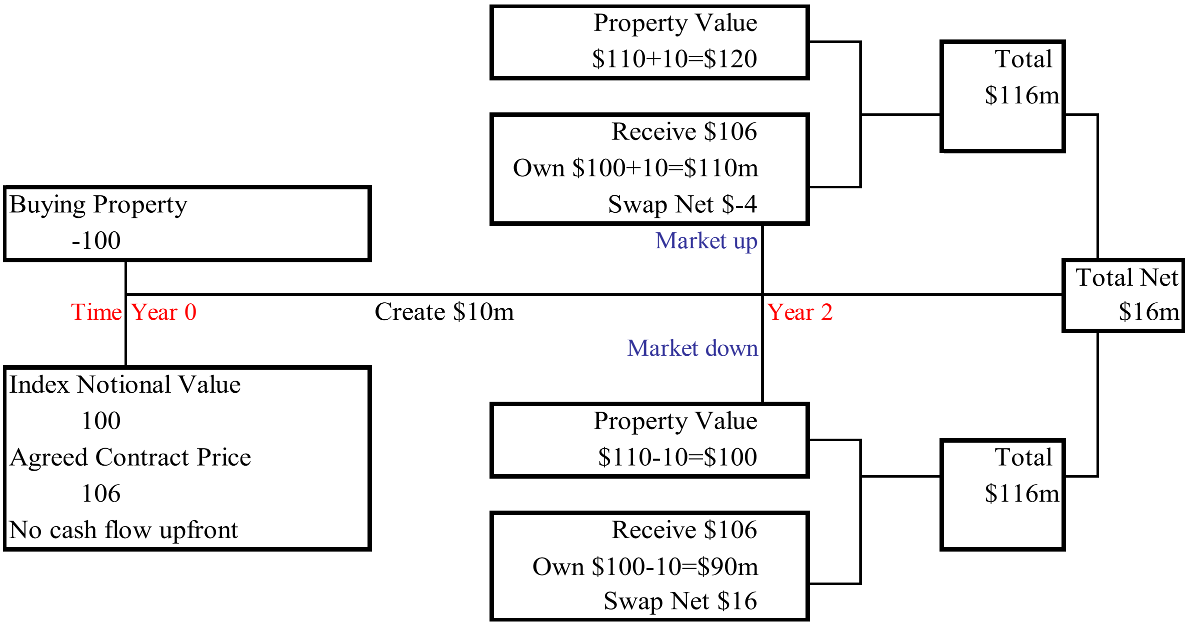
[8] LIBOR: London Interbank Offered Rate is a daily reference rate based on the interest rates at which banks borrow unsecured funds from other banks in the London wholesale money market (or interbank market).
[9] Jani Venter, "Barriers to Growth in the US Real Estate Derivatives Market." MSRED Thesis, 2007.

1.3. The Principles of Hedging with Property Derivative

The definition of hedging in this study refers to any taking of the short position in the property derivatives where the short position is “covered” in the sense of holding properties. The property derivatives refer to the contracts written on the Investment Property Databank (IPD) Index in the UK market.

The basic idea of using property derivatives to hedge risk is to take the short position to neutralize market (systematic) risk as much as possible. To elaborate on how hedging works, let’s consider an example (see Figure 1-1). Suppose a real estate investor who finds a “real bargain” office property for $100 million. She has confidence that she can redevelop creatively and turn around the building to add 10% or $10 million value in 2 years. To protect her project from the market risk, she buys a two-year short contract of swap with the same notional value of the office building, $100 million. The agreed short contract price is supposed to be $106m. If the office market falls 10% in 2 years, the building after redevelopment is worth $100m. That includes $90m current value plus $10m value added. By receiving the contract price and paying the index return, the investor will get cash upfront of $116m. With $10m loss on the office building, $10m due to value added, and $16m gain on the derivative contract, the investor has $16 of net profit for this synthetic investment. The swap successfully protects the property value from market downturn.

Figure 1-1: The Hedging by Swaps



In the case where the office market goes up in two years, the value of the building is an accrued $20m; there is $10m value appreciation and $10m added by the renovation. At the end of Year 2, the investor pays out index return $110m and receives swap price $106m, leaving $4m loss on the swap. However, considering the appreciated value $20m of office building, the investor can still own net $16m (20-4=16m) by the synthetic investment. Therefore, we can see from the example that by hedging, the investor locks in the profit of her property no matter what happens in the market. The detailed processes show in Figure 1-1.

Chapter 2: Hedging Usage Typology and Relevant Risk

The example in Section 1.3 is too good to be true. In practice, investors cannot predict the value of either derivatives or underlying properties so accurately. Not all substantial risks can be hedged away by the property derivative.

2.1. What is Basis Risk?

The critical risk determining the hedging gives rise to the term of basis risk. In general, basis risk is defined as the difference between the return of property portfolios and the return of the index upon which the property is to be hedged. The definition of basis risk can be expressed as:

$$\mathbf{R_b = R_i - R_I} \qquad (1)$$

where:

- R_b represents the basis risk
- R_i is the return of property or portfolio
- R_I is the return of the index

If the return of the underlying properties (R_i) is identical with the return of the index (R_I), the basis risk is zero. In the real estate industry, however, it is impossible to have zero basis risk because every property has its idiosyncratic risk[10]. To understand how the idiosyncratic risk builds up the basis risk, let's go a little further in analyzing Equation (1).

First, I define a positive alpha expectation in the portfolio's return. "Alpha" here refers to the portfolio outperformance in excess of the index. Second, for both the index and the portfolio, the return includes two components: an expected component *(ex ante)* and an unexpected component.[11] Then the equations of the return are:

$$\mathbf{R_i = E[R_I] + \alpha + \Delta_i \; ; \; R_I = E[R_I] + \Delta_I}$$

Now, the basis risk then can be expressed in a more detailed formula:

$$\mathbf{R_b = R_i - R_I = \alpha + (\Delta i - \Delta I) = \alpha + \varepsilon_i} \qquad \textbf{(2)}$$

where

[10] Idiosyncratic risk (or specific risk) refers to the component of an asset's own total variance in excess of its covariance with the market. Idiosyncratic risk (or specific risk) is diversifiable risk.
[11] Note: "ex ante" = "expected" = a deterministic constant, no risk included.

- α is the expected outperformance of the portfolio
- $E[R_I]$ is the expected return of the index
- ΔI is the unexpected component of return on the traded index
- Δi is the unexpected component of return on the portfolio
- $\varepsilon_i = \Delta i - \Delta I$ is the idiosyncratic or specific risk of the portfolio

Because the risk is often represented by standard deviation and α is a deterministic constant without risk, the basis risk is then:

$$\mathbf{STD\ (R_b) = STD\ (\alpha + \Delta i - \Delta I) = STD\ (\alpha + \varepsilon_i) = STD\ (\varepsilon_i)} \qquad \mathbf{(3)}$$

Equation (3) shows that the basis risk essentially is the idiosyncratic risk of the portfolio. It is absolutely uncorrelated with the market (systematic) risk[12]. Thus, hedging with the index cannot take away any basis risk. Unlike the stock market where hedgers can find a specific derivative product to hedge an individual stock, property derivatives rely on the aggregated index and have no individual product that can offset the idiosyncratic risk of property. Therefore, the basis

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[12] Risk that cannot be diversified away is referred to in asset pricing theory as systematic risk or market risk.

risk might be a greater concern for hedgers in the property market than for those in the stock market.

2.2. Sub-market Risk for Hedging

In addition to the basis risk, there is another important risk for property index hedging: sub-market risk. The sub-market risk is defined as the misalignment of the sub-index return and all-property index return. It arises from market situations where investors cannot find derivative products that closely match their portfolios in terms of geography and property types. In the current property derivative market, the sub-market risk is caused by the fact that most derivative contracts are traded only on the IPD all-property index. Although the IPD delivers comprehensive sub-market indices, these indices are illiquid so far in the market and are rarely traded. Considering that the sub-market risk is attributable to the market (systematic) risk, it would otherwise be eliminated by hedging if the derivative market were mature. Therefore, the sub-market risk is another serious concern of hedgers. But the sub-market risk is not the objective of this study and thus is not a consideration in the following analysis.

2.3. Hedging Usage Typology

In the real world, investors short derivatives with different objectives. Some focus on the elimination of property systematic risk, while others target over-performance in excess of the market. Based on hedgers' different objectives, we can categorize hedging into two major typologies: *β-Avoidance* hedging and *α-Usage* hedging. Each of these has two sub-types with slightly different emphases.

(1) *B-Avoidance Hedger*

The "β" in "β- Avoidance" measures the market (systematic) risk, which includes two components: the market expected return and an unexpected return realization. The β- Avoidance hedger wants mainly to eliminate the systematic risk. To elaborate on how the β- Avoidance hedgers use hedging in different circumstances, we refine two subtypes with examples of a real estate fund, Beta Hedge Fund (BHF): the *Portfolio Rebalancing* hedger and the *Temporary Defensive* hedger.

Portfolio Rebalancing

Suppose the BHF is an active real estate asset manager in the UK and US markets. Recently, the research group forecasts an expected market downturn in the UK and a stable prosperity in the

US. Although BHF has quite diversified portfolios regarding property types and segments in the UK, they realize an urgency to reduce their holdings in the UK and allocate a heavier weight of portfolios in the US. However, the executives in BHF know that any transactions in property holdings could take at least 6 months and the cost of transactions is considerable. Moreover, they are clear in mind that committing to any transaction involves risks. Now a newly hired portfolio manager named Maggie proposes to short 30% value of their portfolios in the UK and to go long the same amount in the US. Her smart strategy is accepted by the board immediately. As the market goes down, BHF can therefore rebalance market exposure, avoiding the market risk in the UK.

The case shows a typical process of how the portfolio rebalancing hedging works. Investors like BHF avoid the risk of market downturns by a combination of short and long contracts. The rebalancing between nations, such as the UK and US, is the most common case. Theoretically, a portfolio could also be rebalanced between sub-segments, such as between the London City and the South-East market, or between the UK industrial and UK office properties. In practice, however, because the trading of the UK property index currently lacks liquidity in all but the all-property index, the portfolio rebalancing is restricted to nations. Moreover, the long position is not necessarily limited to property derivatives. An investor like BHF could long any derivative products if the long and short can be covered by each other.

Temporary Defensive

Other than to rebalance portfolios, some investors may hedge simply in order to get rid of the real estate market exposure as a temporary defensive strategy. The most direct way to get out of the market risk is to sell properties. However, in many cases where a market downturn is expected to be temporary, investors want to keep their portfolios for a long run. Shorting the property index helps solve this problem, avoiding the market shock while maintaining the property holding. So, we can define a second category of β-Avoidance hedger: the *Temporary Defensive* hedger.

In a case of defensive hedging, assume BHF holds properties only in the UK. A reliable market research predicts a market tremble in the short term. The experienced managers in BHF have quite a confidence in their property portfolios in the long run, but do not want to undertake the short term loss. With the temporary defensive strategy, BHF can enter into a shorting contract with, for example, one year duration, to reduce the exposure to the UK market and to protect its portfolio value.

The two examples from BHF illustrate the main uses of hedging for β-Avoidance hedgers. In both cases, the investors adopt hedging strategies in order to avoid the market downturn by eliminating the market (systematic) risk. The portfolio rebalancing strategy fits the investors who can reallocate portfolios to avoid market downturns, while the temporary defensive strategy applies to any investors who fear the market shock but want to keep the properties in the long run. However, both hedging strategies will take effect only if the market forecast is in the right direction. Otherwise, hedgers have to take the risk of losing more than that without hedging.

（2） *α -Usage Hedger*

The other major type of hedger is called *α-Usage* hedger. The “α” here refers to a positive expectation in excess of the IPD index. It reflects the ability of investors to outperform the market. The α-Usage hedgers do believe their ability to deliver alpha and intend to use hedging to maintain or improve their alpha achievement. This study defines two kinds of α-Usage hedgers: the *α-Transport* hedger and the *α-Harvest* hedger. To explain the characteristics of the two α-Usage hedgers, we can discuss an imaginary real estate manager, Alpha Harvest Asset Management (AHAM).

α -Transport Hedger

Suppose AHAM is a multi-asset manager that holds not only real estate but also bond portfolios. As the real estate market is heating up, AHAM feels quite confident that investment in real estate could achieve positive alpha. Many senior executives of AHAM intend to convert part of the bond investments to real estate. Their biggest concern with this strategy is that the volatility of the real estate market is much higher than that of the bond market. The newly hired portfolio manager, Maggie, then comes up with an alternative idea, which not only could avoid the risk in real estate but also would harvest the real estate alpha. What does she suggest? She transports capital from bonds to value-added properties, and then shorts the property index with the same amount as that she just spent on the properties. As a result, AHAM creates decent alpha from its real estate venture and protects itself from the volatility of real estate market.

This case portrays a typical scenario for α-Transport hedgers. Because returns from real estate are in general closer to but higher than bonds, the transporting activities usually happen from bonds to real estate. Moreover, α-Transport hedgers have limited risk-bearing capability and want "safe" alpha achievement. Hedging is an effective way to eliminate the market (systematic) risk and thus to help achieve safer alpha.

α -Harvest Hedger

Compared α-Transport hedgers, α-Harvest hedgers are not necessarily multi-asset investors. They focus more on the alpha harvest and usually require higher alpha achievement. Suppose HAHM is a pure real estate manager with a firm self-belief and strong ambition to outperform the market—that is, achieve positive alpha. As the real estate market goes up, HAHM plans a broader exposure in real estate and decides to employ debt to expand the portfolio size. The involvement of leverage, however, levers up portfolio returns as well as risk, which becomes a significant concern for the fund. The portfolio manager Maggie, who specializes in synthetic investment, then decides to acquire the new portfolio in debt and short the same notional amount of the IPD Index. By this strategy, HAHM expands the property sizes, harvests high alpha and controls the property risk at hand.

In this case, the α-Harvest hedger is distinguished from α-Transport hedger by the use of leverage. Realistically, it is not necessary for α-Harvest hedgers to use leverage. But many investors have to employ leverage to implement real estate deals. In spite of magnifying return and alpha, leverage increases portfolio risks. Thus, hedging at least helps reduce the market (systematic) risk for investors.

（3） *Speculation Hedger*

Besides the four fundamental uses of hedging introduced above, I have to point out another kind of hedging use: *Speculation*. Speculation hedgers simply short the index to benefit from market downturns without underlying properties. The Speculation user does not care about risk reduction and therefore is not discussed in this study.

In short, this section categorizes two fundamental types of hedgers by their different objectives and portfolio performances. In comparison, β- Avoidance hedgers aim to get out of the market downturn by eliminating the systematic risk. They may hold broadly diversified portfolios, which are highly correlated with the market risk. α -Usage hedgers intend to achieve positive alpha, while keeping the portfolio risk under-controlled. They probably have ability to beat the market and want to achieve safe alpha without taking the market (systematic) risk. Note that all the hedging typologies are defined for analyzing how hedgers with different objectives consider the effect of basis risk differently. In reality, investors may employ complex hedging strategies with more than one objective.

2.4. The Risk Consideration for Different Hedging Uses

With different goals for hedging, different hedgers consider the basis risk from different perspectives.

Because β-Avoidance hedgers try to avoid market crashes, the first risk they care about is the market (systematic) risk. Apart from the systematic risk, basis risk (or idiosyncratic risk) does create certain volatility that would not be taken away by hedging. But considering that β-Avoidance hedgers may hold highly diversified portfolios and undertake quite small basis risks, the basis risk or idiosyncratic risk would not be a primary aim for them. Besides, we see that in a market crash where everything goes down at the same time, the portfolio idiosyncratic risk becomes much lower than usual and thus could be less of a concern to β-Avoidance hedgers.

Table 2-1: The Consideration of Basis Risk by Different Hedgers

	β-Avoidance Hedgers	**α-Usage Hedgers**
No Expected Positive Alpha	• Don't care much about the idiosyncratic risk (can diversify)	Not Applicable
	• Do care about (would like to hedge) systematic risk	
Positive Alpha Expectation	• Want to keep idiosyncratic return (because it's the source of positive α)	•Want to keep the idiosyncratic return (because it's the source of positive α)
	• Don't care much about the idiosyncratic risk (can diversify)	• Do care about the idiosyncratic risk (would like to hedge it but can't due to above)
	• Do care about (would like to hedge) systematic risk	• Do care about (would like to hedge) the systematic risk

The α-Usage hedgers usually have a firm belief on their ability to "beat" the market and achieve positive alpha. They would like to diminish the market (systematic) risk, while achieving the positive alpha. The positive alpha realization, however, is highly integrated with the idiosyncratic risk or basis risk. As we know from Capital Asset Pricing Model (CAPM) [13], if a portfolio has no idiosyncratic risk (basis risk), the portfolio is a market portfolio whose alpha then should be zero (no alpha). That is, if investors can harvest or transport positive alpha from their portfolios, the portfolios must be subjected to the idiosyncratic risk. The integration between positive alpha and portfolio idiosyncratic risk is too close to take apart without affecting the positive alpha. Thus, α-Usage hedgers may have to keep the idiosyncratic risk and deal with the volatility caused by this risk.

In summary, we find that both β-Avoidance hedgers and α-Usage hedgers would like to take the systematic risk away. Comparably, β-Avoidance hedgers do not care about the idiosyncratic risk as much as do α-Usage hedgers. The α-Usage hedgers do care the idiosyncratic risk and have to keep it along with the positive alpha. Table 2-1 shows a clear summary for the different concerns for hedging risks.

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[13] Capital Asset Pricing Model (CAPM) first introduced the concept of separating risk into systematic risk and idiosyncratic risk. The main formula of CAPM is: $(R_i - R_f) = \alpha + \beta \times (R_I - R_f) + \varepsilon_i$

Chapter 3: Study Method and Results

3.1. The IPF Study

(1) *Outline of the IPF Study*

The research by the IPF Educational Trust and IPF Joint Research Program in 2007 records a comprehensive study on return and risk of different-sized property portfolios in the UK. By time-series and cross-section analysis, the study traces the variation of risk for different sizes and across segments of portfolios from 1994 to 2004.

The objective of the IPF study is to explore the risk reduction and diversification in the UK market. Specific risks (or idiosyncratic risk) associated with both individual properties and fund portfolios can be reduced by portfolio construction—and that's why it is the key focus of the IPF study. By answering the question of to what extent the diversification and risk reduction can be achieved in the UK market, the study gives valuable parameters to policy makers and investors.

The individual and portfolio data used in the study is taken from Investment Property Databank (IPD) annual bank. The data covers around 11,000 properties and includes approximately 50% of all commercial properties held by institutional investors in UK. The IPD constructs thousands of hypothetical portfolios by randomly combining the held properties, using Monte Carlo simulations. The portfolios in this study are drawn from those hypothetical IPD portfolios.

The IPF study makes use of both time-series and cross-section analysis to test the risk mitigation and risk diversification, while taking into account the number of properties in a portfolio. The cross-section analysis measures the range in portfolio returns in a single year and then compares the ranges for portfolios with different sizes. The time-series analysis includes two parts. The first part examines the risk and return reduction on various-sized hypothetical portfolios with 2 to 500 properties. This part also compares portfolio returns, using the IPD all-property index as the benchmark, to evaluate the effectiveness of diversification. The second part is about the main characteristics of individual properties; it covers property annual returns, correlations between individual properties and correlations between each individual property and the market.

Monte Carlo simulation method is used in both cross-section and time-series analysis in the IPF study to construct hypothetical portfolios of varying sizes (with property counts ranging from 2 to 500). All of the sample properties and portfolios were obtained by random selection without replacement from the available sets of individual properties. For each portfolio size, the random selection process was repeated 20,000 times in the cases of the cross-sections and 5,000 times in the time-series simulations. At each portfolio size, average returns, average volatility, and ranges in returns across all the trials are then calculated.

（2） *Study Results and Questions to be Answered*

Figure 3-1: The Report of Tracking Errors of the IPF Study

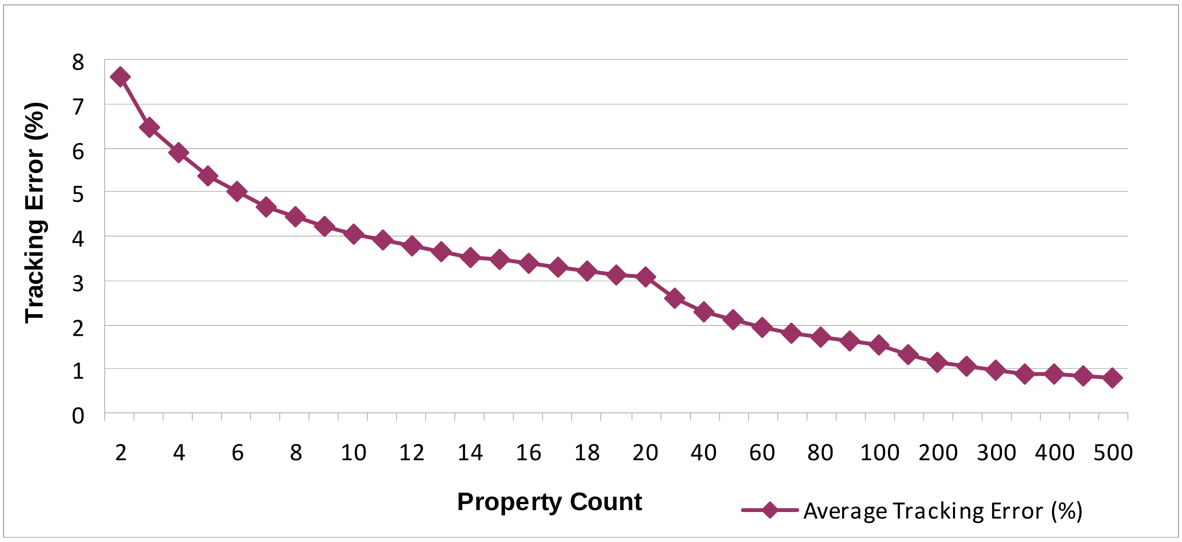


Table 3-1: The Report of Tracking Errors in the IPF Study

Tracking Error	**3**	**5**	**10**	**20**	**50**	**100**	**500**
Tracking Error	6.48%	5.35%	4.06%	3.06%	2.09%	1.54%	0.78%

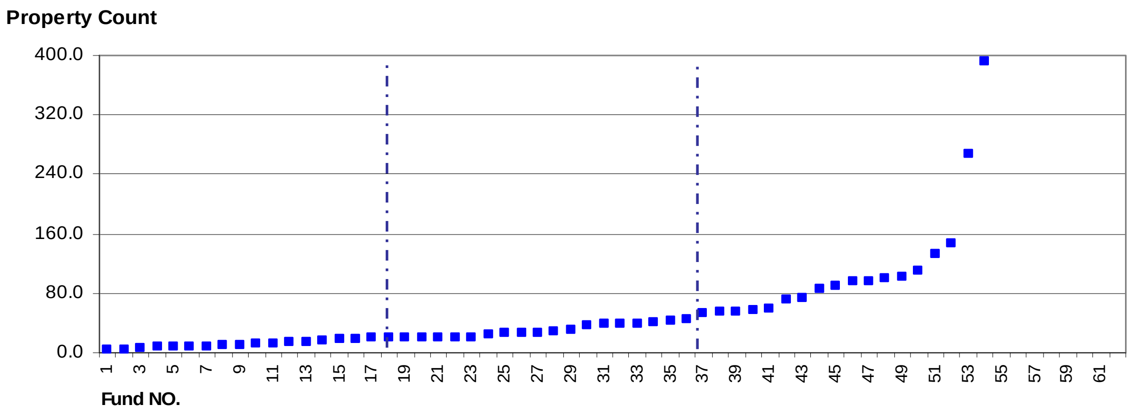
The results of the study highlight the risk reduction with the increase on portfolio sizes. Because portfolios have limited sizes, they are subject to the specific or idiosyncratic risk in addition to the market risk. To illustrate how much specific risks the portfolios have to take, the

IPF study reports a detailed average tracking errors or basis risks from different sized hypothetical portfolios (see Figure 3-1 and Table 3-1). Figure 3-1 shows that the basis risk is reduced by adding properties to the portfolios. For example, the portfolio with 3 properties has 6.48% basis risk, and the portfolio with 20 properties has the basis risk less than 50% of the 3-property portfolio. The diversification effect experiences a jump when the property counts increase from 20 to 30. The basis risk of the biggest portfolio (with 500 properties) is only 0.78%, indicating that the portfolio's risk is close to the market risk. The IPF report about tracking errors provides background information for this thesis to interpret the impact of basis risks on hedging with property derivatives.

3.2. Monte Carlo Simulation

This thesis uses a tailored Monte Carlo simulation model to examine the effectiveness of hedging with different basis risks, as well as the role hedging plays for different types of hedgers. The model assumes the hedger is a pure real estate investor without other asset holdings. This is just a convenient assumption so that we can focus on the pure effect of hedging. The broader interpretation is that we are focusing only on the impact of hedging per pound (or dollar) of hedged property investment. The property derivative studied is the swap, the major product traded in the market. The basis risks to be tested in the model are selected from the IPF study introduced earlier in this chapter. In order to cover the basis risks with different-sized portfolios in the UK market, this thesis chooses sample basis risks from the portfolios with 3, 5, 10, 20, 50, 100, and 500 properties (see Table 3-1).

Figure 3-2: Property Counts for the UK Funds



In order to figure out the range of property counts of portfolios in the real world, I examine a data set provided by IPD about 62 UK property funds. As is shown in Figure 3-2, the property counts range from 5 to 398. This research divides these funds evenly into three groups: Small, Medium, and Large, with the same number of funds in each category. The means for property counts in each category is 12, 30, and 113. Thus, the Monte Carlo model examines basis risks of large-sized portfolios by studying those with 100- property and 500-property portfolios.[14] The medium-sized portfolios are analyzed by portfolios with 20 and 50 properties. Considering that

[14] Guoxu Xing, An Analysis of U.K Property Funds Classified According to U.S Styles: Core, Value-added and Opportunistic, MSRED Thesis, 2009.

adding properties in small portfolios makes a more significant change in basis risk than in the big ones, the model takes three basis risk samples to represent the small portfolios, including portfolios with property counts of 3, 5, and 10.

The key variables in the Monte Carlo model are the market return and the alpha realization each year, over a presumed three-year hedging horizon. Each variable includes a constant component that represents the equilibrium expectation, and a random component that represents the unexpected realization of risk or volatility (standard deviation) across time. The random risk realizations for the two variables are both based on the inputs of volatility. The market return volatility maintains the same input during the three years, while the basis risk input varies among the different-size portfolios. The two components of the market return, the expected return and the unexpected volatility, are derived from the general market data. The “alpha” is defined as the constant positive expectation that represents the difference between the properties' performance and the IPD universe index. This constant indicates the ability of “alpha-usage” hedgers to beat the market. The volatility input of alpha for random trials is taken without change or alteration from the IPD study’s basis risk report.

To explain in detail why the basis risk can represent the alpha volatility in the model, let’s recall the definition of the basis risk in Chapter 2. From Equation (1):

$$\mathbf{R_b = R_i - R_I} \quad \textbf{(1)}$$

Equation (1) is also the basic formula by which IPF calculates the basis risk. According to the Capital Asset Pricing Model, we express the return of portfolios as:

$$\mathbf{(R_i - R_f)} = \alpha + \beta \times \mathbf{(R_I - R_f)} + \varepsilon_i \quad \textbf{(4)}$$

Because the hypothetical portfolios are randomly selected by the Monte Carlo simulation from the IPF property data universe, the β is supposed to be 1. Therefore, we can rewrite Equation (4) as:

$$\mathbf{R_i - R_I} = \alpha + \varepsilon_i \quad \textbf{(2)}$$

This result is equivalent to Equation (2), by which we analyzed the definition of the basis risk in Section 2.1. Deriving the equation on both sides, we get back to Equation (3) in Section 2.1:

$$\mathbf{STDEV(R_i - R_I) = STDEV(R_b) = STDEV(}\alpha + \varepsilon_i\mathbf{) = STDEV(}\varepsilon_i\mathbf{)} \quad \textbf{(3)}$$

From Equation (3), we see that the constant component of α (the prior expectation to beat the market, as described above) has zero standard deviation (by definition). Thus, the entire basis risk realization is in the ε_i component, which is seen in Equation (3) to be the random realization of the R_i -R_I, the "tracking error" quantified in the IPF study. Equation (3) demonstrates that the basis risk indicates the alpha volatility, which is purely the specific risk of the portfolio. The detailed inputs of the model can be seen in Table 3-2 for the 3-property portfolio, which the IPF study reports has a standard deviation of tracking error of 6.48%.

By running 2,000 trials stochastically from the two probability distributions (for the realizations of the market return random component and the ε_i tracking error), the Monte Carlo model provides three measures related to hedging: it gives the portfolio's average *ex post* return, its volatility, and its achieved alpha. It seems likely that all three measures would be of great concern to hedgers, no matter if they are β-Avoidance hedgers or α-Harvest hedgers.

Figure 3-3: The UK Fund Classification: LTV and Volatility

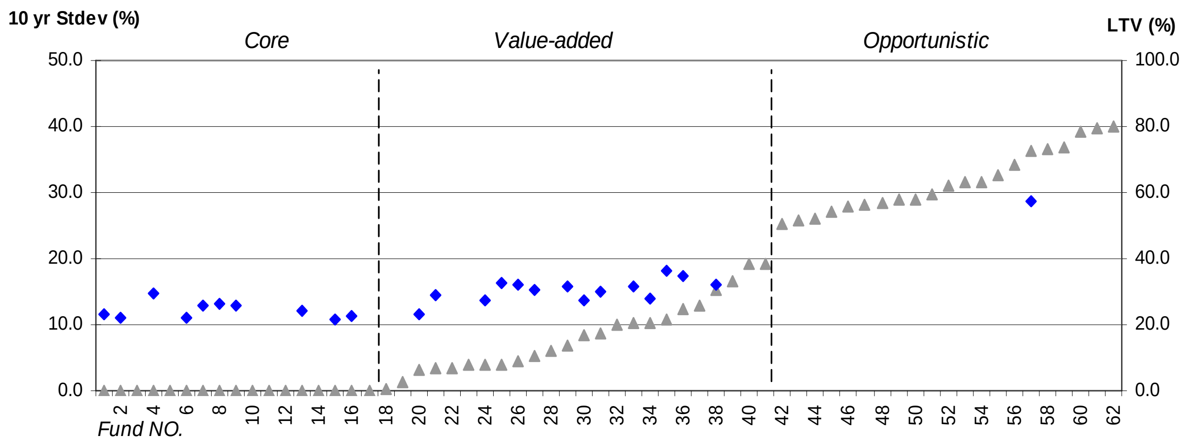


Table 3-2: The Inputs of the Monte Carlo Simulation

Simulation inputs:	Year.1	Year.2	Year.3
Enter forecasted RE Returns	7.00%	7.00%	7.00%
Enter forecasted Alphas	2.00%	2.00%	2.00%
	RE Return Volatility	Alphas Volatility	
Enter volatilities	10.00%	6.48%	

Future *Ex Post* Returns:					
End of Year:	Stock Return	Bond Return	RE Return*	LIBOR	HHAM Alpha*
1	0.00%	0.00%	5.79%	5.00%	4.07%
2	0.00%	0.00%	11.27%	5.00%	-1.91%
3	0.00%	0.00%	-10.44%	5.00%	1.05%
G-Mean:	0.00%	0.00%	1.78%		
Volatility:	0.00%	0.00%	11.29%		

In order to test the efficiency of different types of hedging, three scenarios are examined in the model. Considering that β-Avoidance hedgers need not have any positive alpha expectation and are risk-averse, the first scenario is designed without alpha and leverage, focusing on the hedging impacts of most interest to β-Avoidance hedgers. By adding a positive alpha, the second scenario is most relevant for α-Transport hedgers. α-Transport hedgers expect positive alpha but have limited risk tolerance. By transferring capital from other assets, such as bonds, to real estate, they avoid the need to use leverage. Thus, Scenario 2 has no debt involved in the model. In Scenario 3, leverage is introduced in the model to represent the hedging of α-Harvest hedgers. These hedgers target positive alpha as much as possible, as do the opportunistic funds in the UK. Thus, the leverage used in the model is set up as 65% Loan-to-Value, which is the average debt ratio in the UK opportunistic funds. The leverage and volatility of the UK funds is analyzed in Figure 3-3. [15] We need to note that all of these classifications are of course stylized for illustrative purposes. The real world may involve complex combinations of various hedging motives.

Table 3-3: The Outputs of the Monte Carlo Simulation

Hedge Returns:			
Year:	**With Swap**	**Without Swap or Debt**	**Difference**
1	14.56%	17.96%	-3.40%
2	-1.02%	15.44%	-16.47%
3	4.11%	-29.71%	33.82%
G-Mean:	5.69%	-1.45%	7.14%
Volatility:	7.94%	26.82%	-18.88%
Fund Systematic Risk:	0.09	2.57	-248.80%
Fund's Market Expected Return (exclude alpha):	5.17%	10.15%	-4.98%
Fund Achieved Alpha:	52	-1159	1211

To stimulate thoughtful analysis, the model includes other elements that could impact hedging, including swap market price and debt cost. The swap price in the model is expressed as risk-free rate or the LIBOR, minus half of the bid-ask spread[16] of 0.8%. Aside from the swap price, the model sets a constant debt price with 0.5% over the LIBOR. The results of the analysis are illustrated in the next section.

[15] Guoxu Xing, An Analysis of U.K Property Funds Classified According to U.S Styles: Core, Value-added and Opportunistic, MSRED Thesis, 2009

[16] Bid-ask spread is the spread between the "bid" (buy) and the "ask" (sell) price. It is paid half-and-half by each party in a swap contract to the derivative facilitator, such as an investment bank.

3.3. Analysis Results and Implications

(1) *Scenario 1: E[α] =0; LTV=0*

Table 3-4: The Simulation Results in Scenario 1

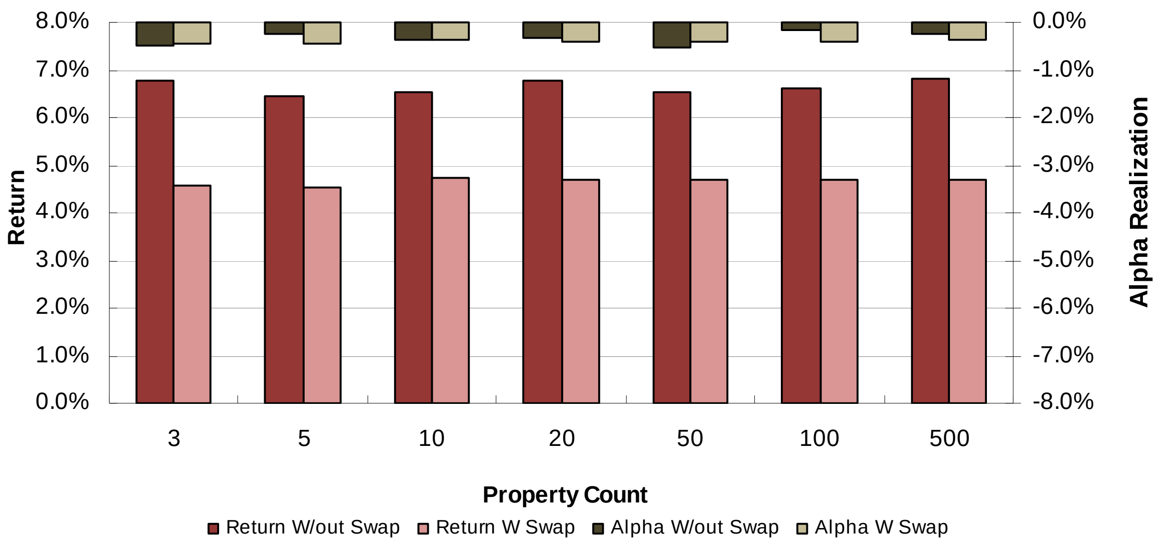
E[α] =0;	**LTV=0**							
		3	**5**	**10**	**20**	**50**	**100**	**500**
Mean Return	W/ out swap	6.78%	6.44%	6.53%	6.77%	6.53%	6.62%	6.81%
(%)	W swaps	4.56%	4.53%	4.75%	4.70%	4.69%	4.69%	4.70%
	Difference	-2.22%	-1.91%	-1.78%	-2.08%	-1.85%	-1.93%	-2.11%
Return Volatility	W/ out swap	10.56%	10.56%	9.34%	9.29%	8.92%	9.14%	8.82%
(%)	W swaps	5.66%	5.74%	3.62%	2.71%	1.92%	1.42%	0.85%
	Difference	-4.90%	-4.82%	-5.72%	-6.58%	-7.00%	-7.72%	-7.97%
Realized Alpha	W/ out swap	-47	-23	-37	-31	-51	-16	-26
(bps)	W swaps	-44	-46	-37	-42	-42	-39	-38
	Difference	4	-23	0	-10	9	-23	-12
Systematic Risk	W/ out swap	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	W swaps	0.044	0.042	0.044	0.045	0.045	0.045	0.045
	Difference	(0.956)	(0.958)	(0.956)	(0.955)	(0.955)	(0.955)	(0.955)

The first scenario tests the cases of β-Avoidance hedgers. Both portfolio-rebalancing hedgers and temporary defensive hedgers enter into hedging contracts to remove systematic risks, protecting their portfolios from market downturns. Thus, whether hedging can take away the market risk (systematic risk) is the core question to be answered in this scenario.

The results of the simulation are summarized in Table 3-4, where four characteristics of the hedging are listed. Ranging from 6.78% to 6.81%, the portfolio returns are quite similar before hedging. After that, however, the returns decline by around 2% from the average 6.64% to

4.66%. Figure 3-4 shows that with or without hedging, the ranges of returns are quite small and the dispersion of returns has no significant correlation with portfolio sizes. Hedging reduces the portfolio returns by diminishing the systematic risk. The systematic risk is reduced from 1 to near zero for all portfolios no matter how much they are diversified and how much basis risk they have. This demonstrates the idea mentioned earlier that without the correlation with the systematic risk, the basis risk cannot affect the fact that hedging reduces systematic risk. After removing systematic risk, hedging leaves the basis risks as the main source of return in the portfolios. But the basis risks cannot bring any positive alpha to the portfolios. Figure 3-4 displays the return and alpha realizations in this scenario.

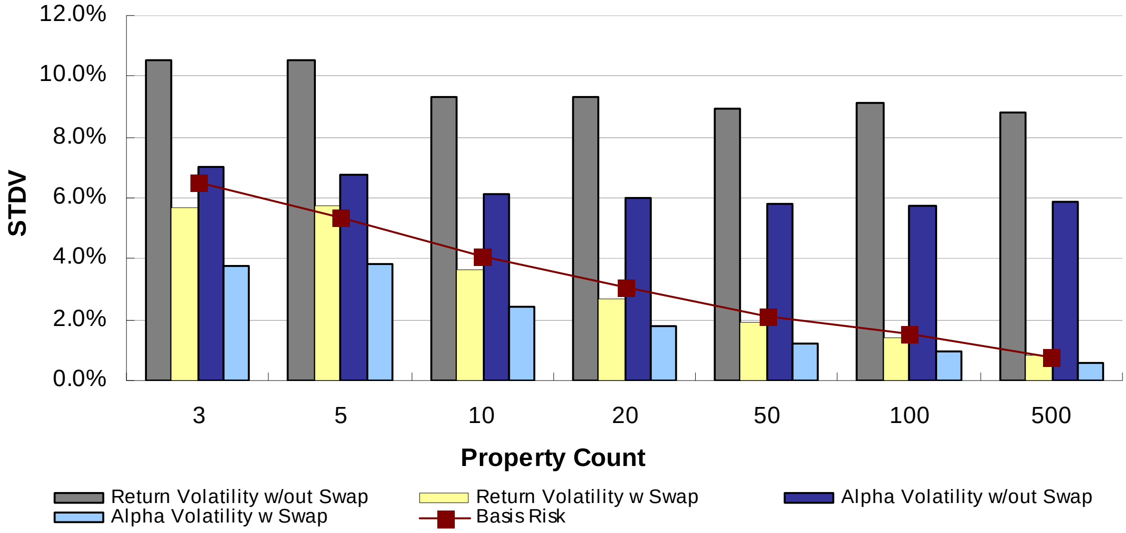
Figure 3-4: The Return and Alpha Realization in Scenario 1



In contrast, Table 3-4 shows that the portfolio volatility without swaps ranges from 10.56% for small portfolios to 8.82% for large ones. Small portfolios tend to have slightly higher volatility than big ones due to the extra specific risk they carry. After hedging, as shown in Figure 3-5, we find that the volatility of returns displays substantial linear decline with the increase of portfolio sizes. The volatility of the smallest portfolio (with 3 properties) is reduced by 4.9% from 10.56% to 5.66%. The biggest portfolio (with 500 properties) has a reduction of around 8%, with only 0.85% volatility left (see Table 3-4). From Figure 3-5, we can see that the alpha volatility of portfolios after hedging is lower than the alpha volatility inputs (the basis risk), ranging from 3.80% for the 3-property portfolios to 0.57% for the 500-property portfolio. All the volatility reductions are mainly caused by the elimination of systematic risk.

Figure 3-5 shows us an obvious fact: big portfolios with smaller tracking errors achieve better reduction of volatility than small ones. In addition, the return volatility after hedging is nearly equivalent to portfolios' basis risk. Therefore, small portfolios with higher basis risk are left with higher volatilities, while big portfolios are left with lower. Thus, hedging reduces volatilities for portfolios of any size by eliminating systematic risk. Due to the disappearance of systematic risk, however, the returns of the portfolios drop to a level lower than that of bonds. Small portfolios with higher basis risk have significantly high volatility after the hedging, while big portfolios with lower basis risk have relatively low volatility. Only big portfolios with property counts over 100 achieve bond-like volatilities.

Figure 3-5: The Return and Alpha Volatility in Scenario 1



Fundamentally, β- Avoidance hedgers can benefit from the reduced systematic (market) risk with a certain cost on return reduction. They actually want to avoid the exposure to real estate market returns, for example, because they believe the real estate market may turn negative. So β-avoidance hedgers are presumably happy to pay the price of a lost return premium in order to diminish the systematic (market) risk.

However, if the hedger holds a small portfolio, she has to face considerable non-systematic risk (specific risk). It seems that only the biggest portfolios, with over 100 properties, can maintain a bond-like total risk. According to the IPD UK-funds data set, however, fewer than 10% of funds have portfolios with property counts of more than 100. But given the fact that β-Avoidance hedgers tend not to care much about specific risks (basis risk), hedging does help them diminish the systematic (market) risk and avoid losses in market downturns.

Figure 3-6: The G-mean of Return Distribution for 3-Property Portfolio in Scenario 1

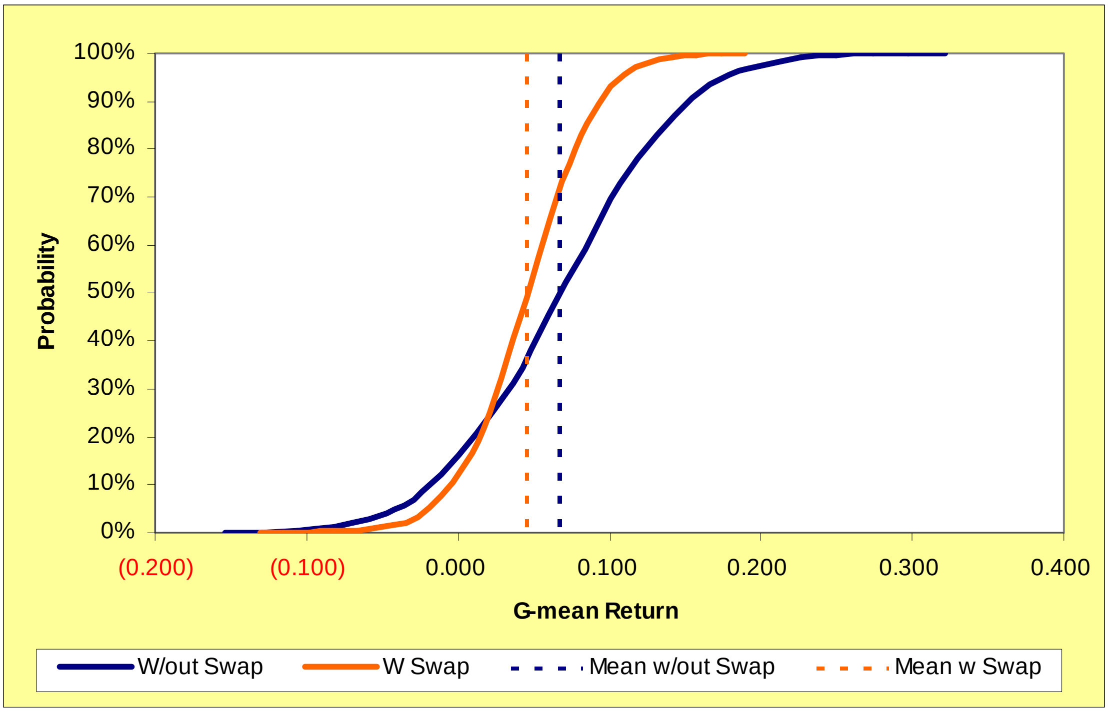


Figure 3-7: The G-mean of Return Distribution for 500-Property Portfolio in Scenario 1

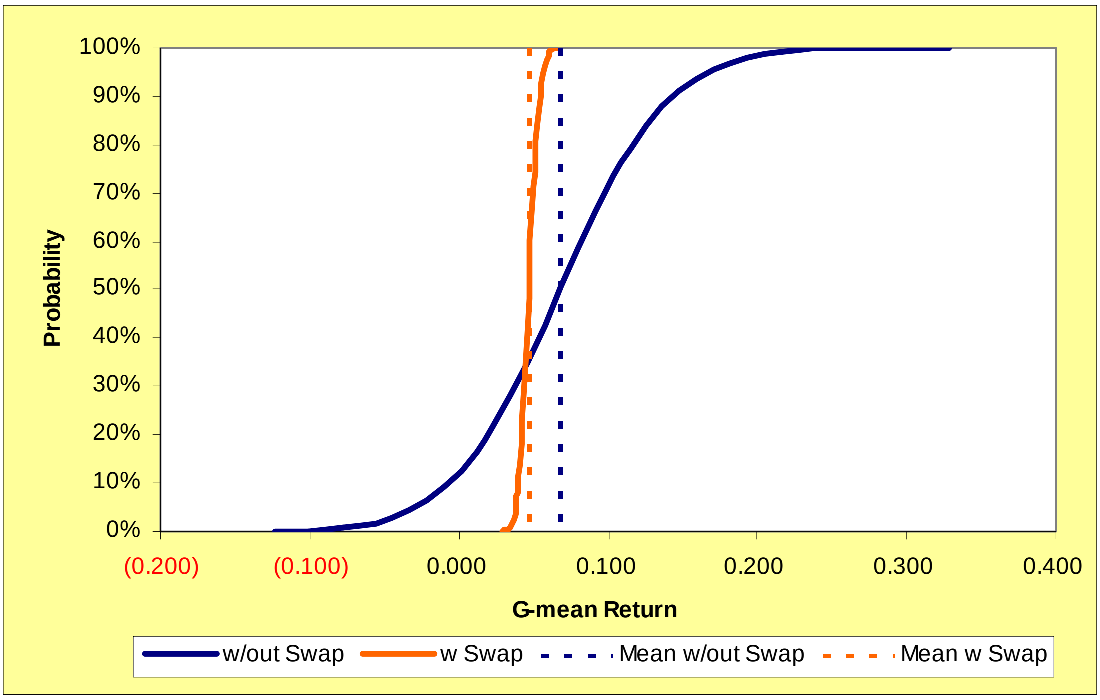


Figure 3-8: The Return Volatility Distribution for 3-Property Portfolio in Scenario 1

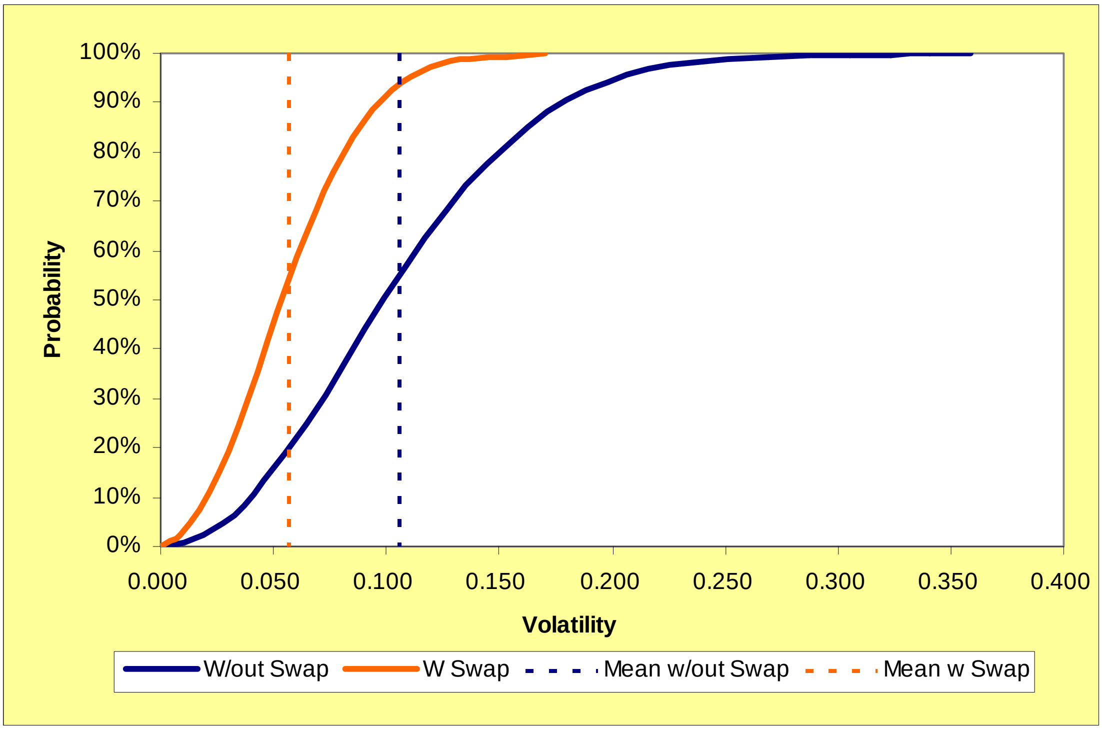


Figure 3-9: The Return Volatility Distribution for 500-Property Portfolio in Scenario 1

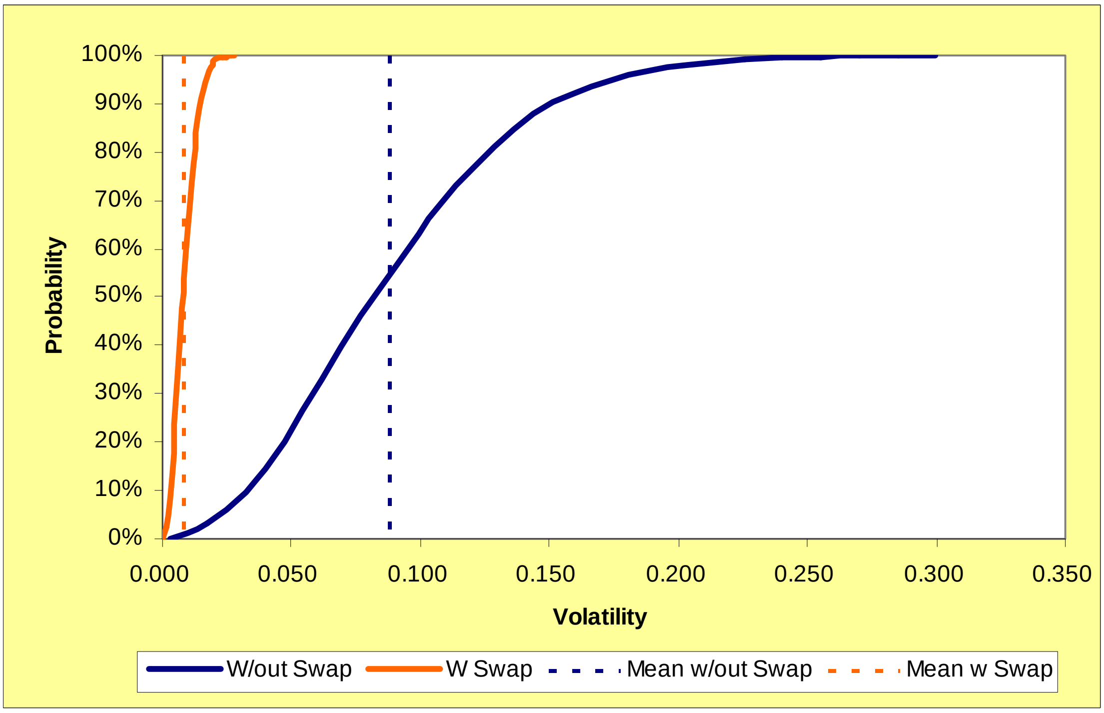


Figure 3-10: The Alpha Realization Distribution for 3-Property Portfolio in Scenario 1

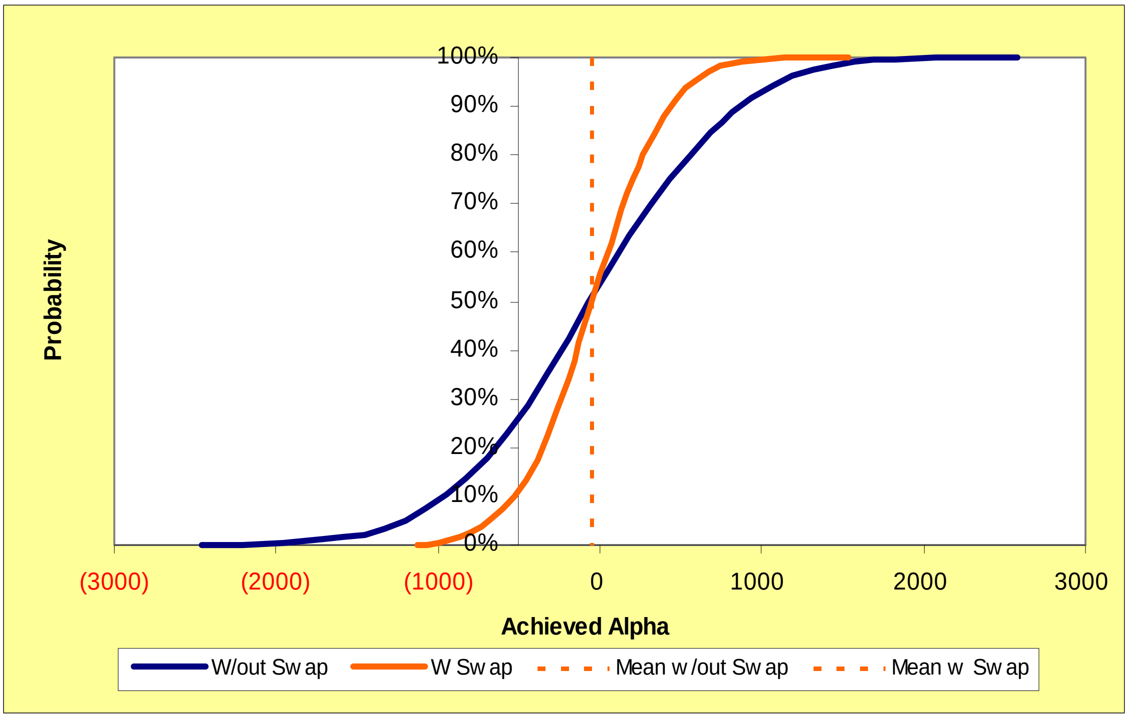
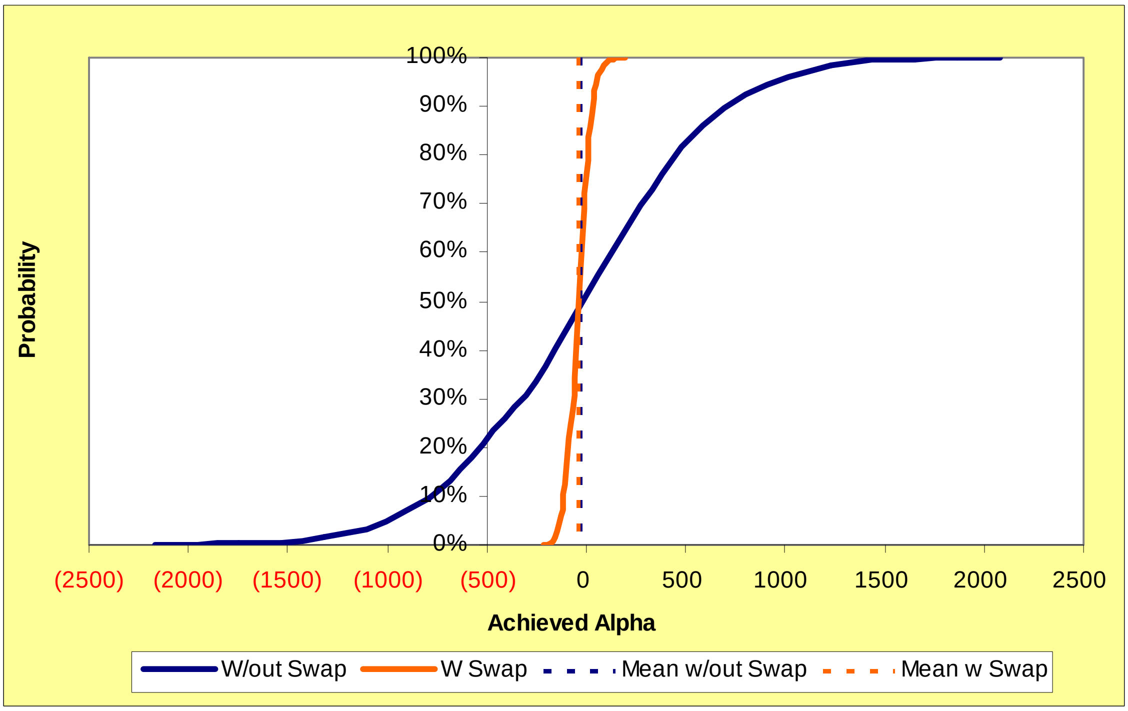


Figure 3-11: The Alpha Realization Distribution for 500-Property Portfolio in Scenario 1



(2) *Scenario 2: E[α] =2%; LTV=0*

By adding a constant alpha expectation, Scenario 2 examines the cases of α-Transport hedgers, who are the multi-asset managers and do not use debt. Table 3-5 shows the detailed analysis results from the simulation analysis.

Table 3-5: The Simulation Results in Scenario 2

E[α] =2%;	LTV=0							
		3	**5**	**10**	**20**	**50**	**100**	**500**
Mean Return (%)	W/out swap	8.51%	8.40%	8.92%	9.04%	8.69%	8.55%	8.76%
	W swaps	6.66%	6.64%	6.73%	6.72%	6.74%	6.76%	6.72%
	Difference	-1.85%	-1.76%	-2.18%	-2.32%	-1.95%	-1.80%	-2.04%
Return Volatility (%)	W/out swap	10.50%	10.22%	9.34%	9.46%	9.00%	9.18%	8.78%
	W swaps	5.61%	4.64%	3.66%	2.79%	2.00%	1.53%	0.98%
	Difference	-4.89%	-5.57%	-5.68%	-6.67%	-7.00%	-7.65%	-7.80%
Realized Alpha (bps)	W/out swap	151	152	191	151	167	160	169
	W swaps	152	154	162	159	164	161	160
	Difference	1	2	-29	8	-3	1	-9
Systematic Risk	W/out swap	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	W swaps	0.065	0.061	0.062	0.063	0.063	0.063	0.064
	Difference	(0.935)	(0.939)	(0.938)	(0.937)	(0.937)	(0.937)	(0.936)

As is shown in Table 3-5, the positive alpha expectation increases the portfolios' returns. Compared to the average returns in Scenario 1, returns in this scenario increase around 2% both before and after hedging: the average return before hedging is 8.70%, higher than the average return of 6.64% in Scenario 1, while the average return after hedging is 6.71%, compared to 4.66%. This increase is definitely attributable to the positive alpha expectation. As it does in

Scenario 1, hedging in this scenario eliminates the systematic risk to nearly zero and reduces the portfolio returns by around 2%.

From Figure 3-12 and Table 3-5, we see that the dispersion of returns has no significant correlation with portfolio sizes. The smallest portfolio (with 3 properties) has a return of 8.51% before and 6.66% after hedging, while the biggest portfolio (with 500 properties) shows returns of 8.76% and 6.72%. For portfolios of any sizes, the return after hedging is higher than the LIBOR or bonds this time. Figure 3-12 illustrates that the alpha realization averages 1.59%, which is close to the alpha expectation. This demonstrates the fact that once systematic risk (the market return premium) falls to zero, the portfolio returns are decided by the alpha expectation--or the hedgers' ability to beat the market.

Figure 3-12: The Return and Alpha Realization in Scenario 2

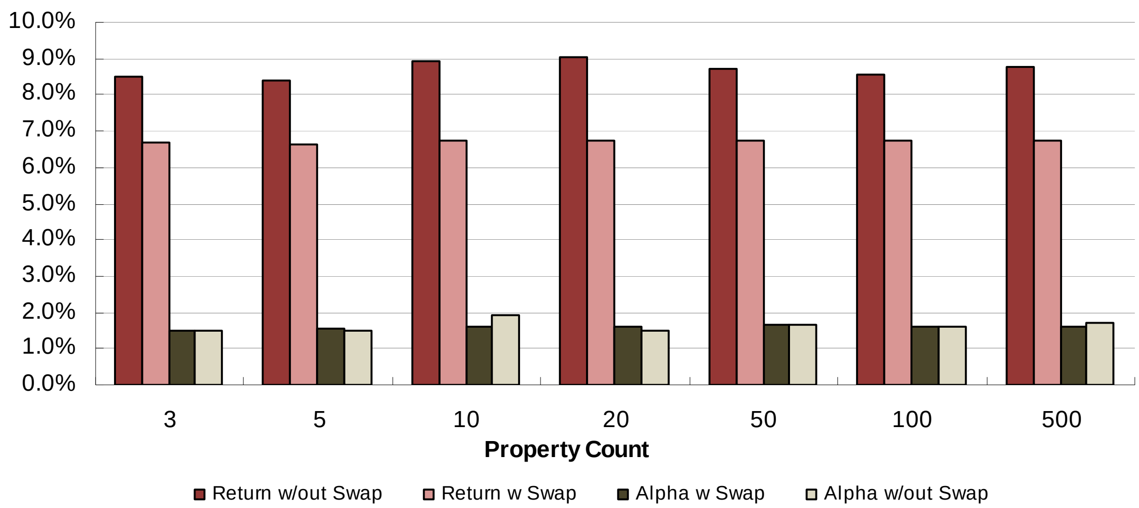


Figure 3-13: The Return and Alpha Volatility in Scenario 2

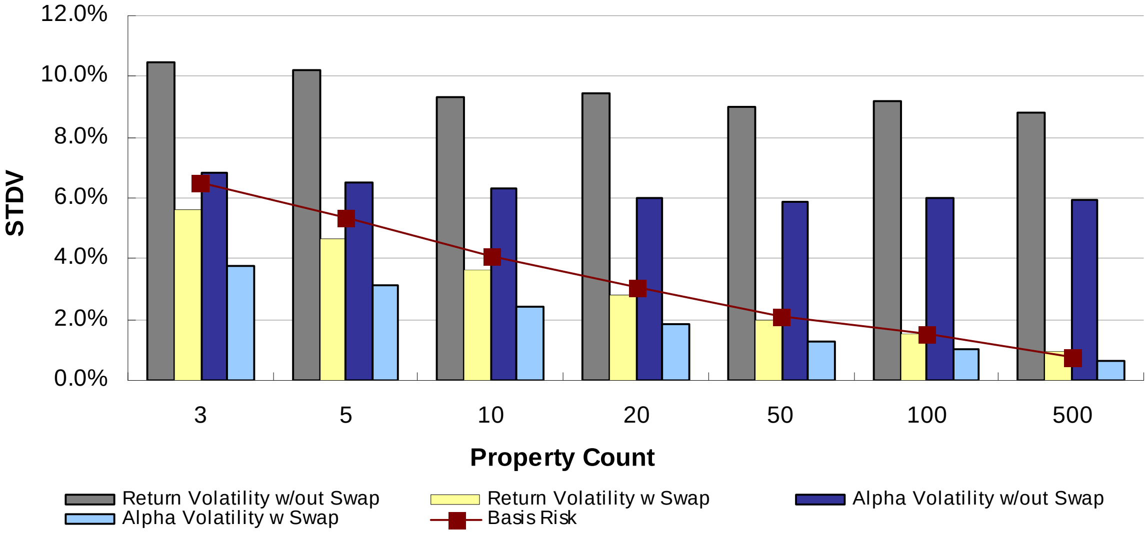


Table 3-5 and Figure 3-13 shows us that the return volatility before and after hedging in this scenario remains at the same level as it is in Scenario1. For example, the volatility for the smallest portfolio is reduced from 10.56% to 5.66% in Scenario 1 and from 10.50% to 5.61% in the current scenario. The average volatility is reduced about 6.47% by hedging to 3.03%, which is 0.08% lower than in Scenario 1. The reason for this consistency in volatility is that the alpha expectation is a constant without any risks. Adding alpha expectation does not change the portfolio risk exposure. The slight differences in the numbers are caused by the random trials and adjustments of simulation model. The changes in alpha volatility demonstrate the same results as in Scenario 1. Hedging eliminates the systematic risk, leaving basis risk as the main risk for portfolios of any sizes. Big portfolios with significantly lower basis risk can achieve more efficient reduction on portfolio volatility.

In short, Scenario 2 shows again that hedging absorbs the portfolio return premium by eliminating the systematic risk. But the positive alpha expectation compensates the reduction of portfolios' return, resulting in higher returns than bonds. In addition, hedging reduces the volatility of portfolios, including the return volatility and alpha volatility. Bigger portfolios with less basis risk achieve better volatility reduction than the smaller portfolios. The detailed distributions of return and volatility for the biggest and the smallest portfolio are shown in the figures from 3-14 to 3-19.

For α-Transport hedgers, hedging fundamentally helps execute the original task, which is to transfer alpha from other classes (bonds for example) and to eliminate the systematic (market) risk. However, how worthy it is to hedge is up to the hedging cost and the quality of alpha. Hedging basically takes the market return premium (2%) off the table by diminishing the systematic risk. The positive alpha expectation, however, compensates hedgers for the reduction of return. Hedging actually gives up portfolios' return in exchange for a "safe" alpha. We notice that if the alpha expectation is much lower than the market premium, it may cost hedgers too much return to obtain a lower risk. The question is how much positive alpha investors can achieve in the real world. The study from Shaun Bond et al reports that the persistent out-performance is very rare in the UK market. Only 25% or so of the funds which probably involve the leverage deliver consistent alpha by around 2% per annum over 6-10 years, and about 1¼ percent over 20 years. Thus, hedgers, especially those holding small portfolios, might take high volatility after hedging and need to measure their own hedging results on a case by case basis.

Figure 3-14: The G-mean of Return Distribution for 3-Property Portfolio in Scenario 2

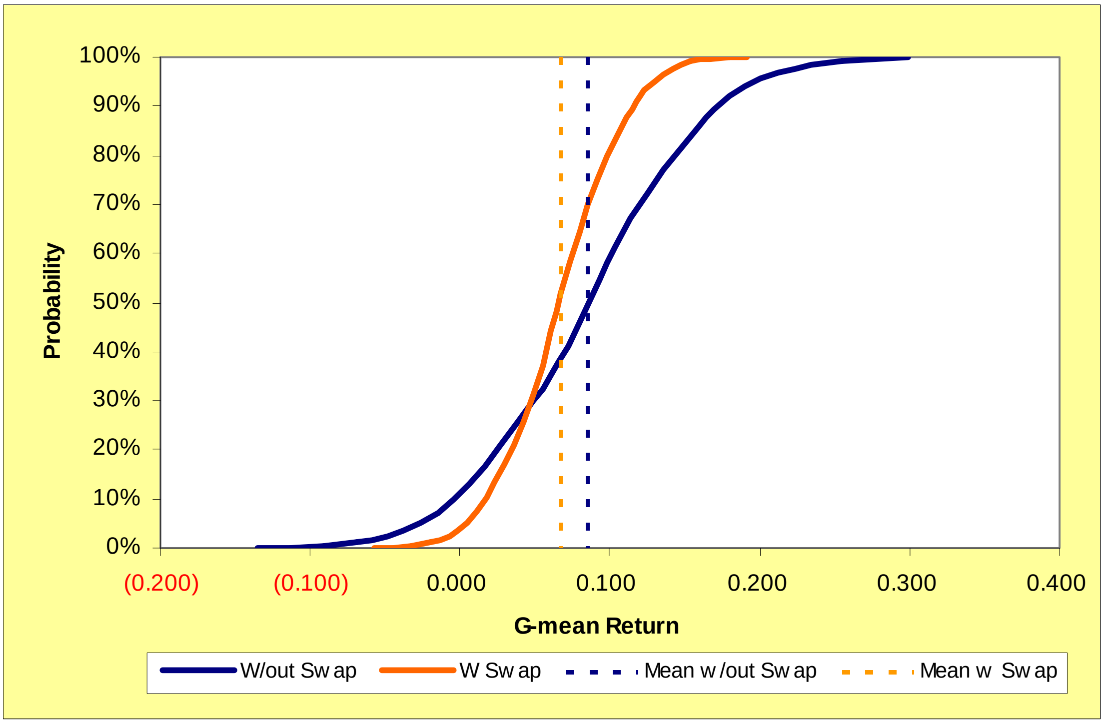


Figure 3-15: The G-mean of Return Distribution for 3-Property Portfolio in Scenario 2

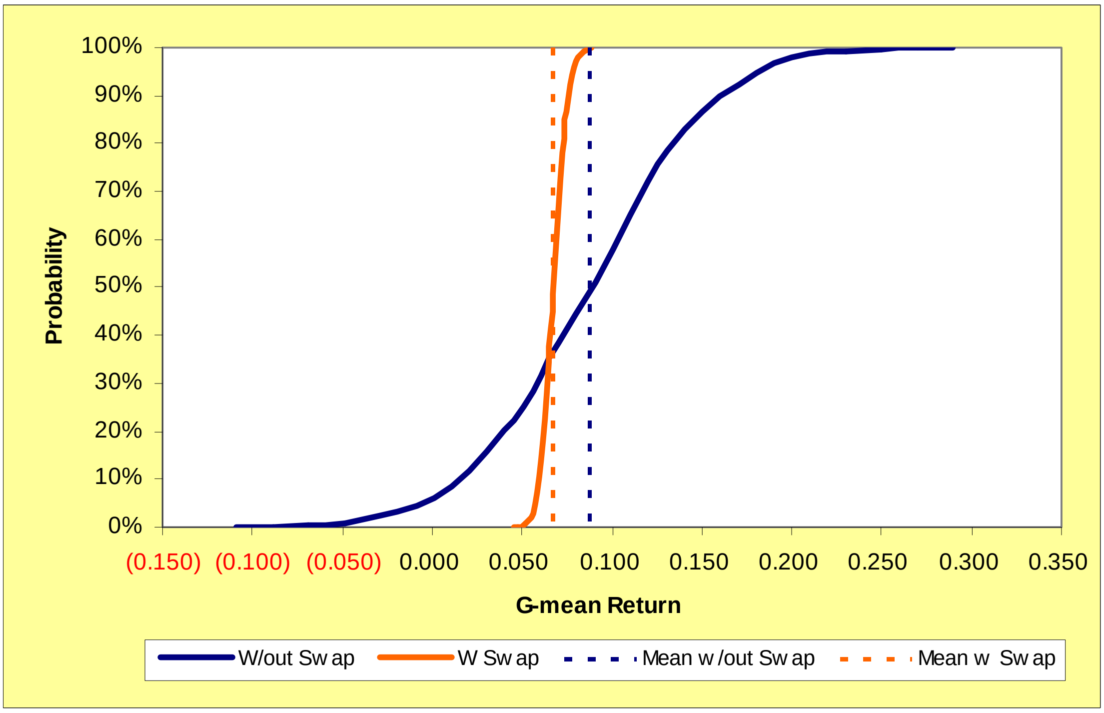


Figure 3-16: The Return Volatility Distribution for 3-Property Portfolio in Scenario 2

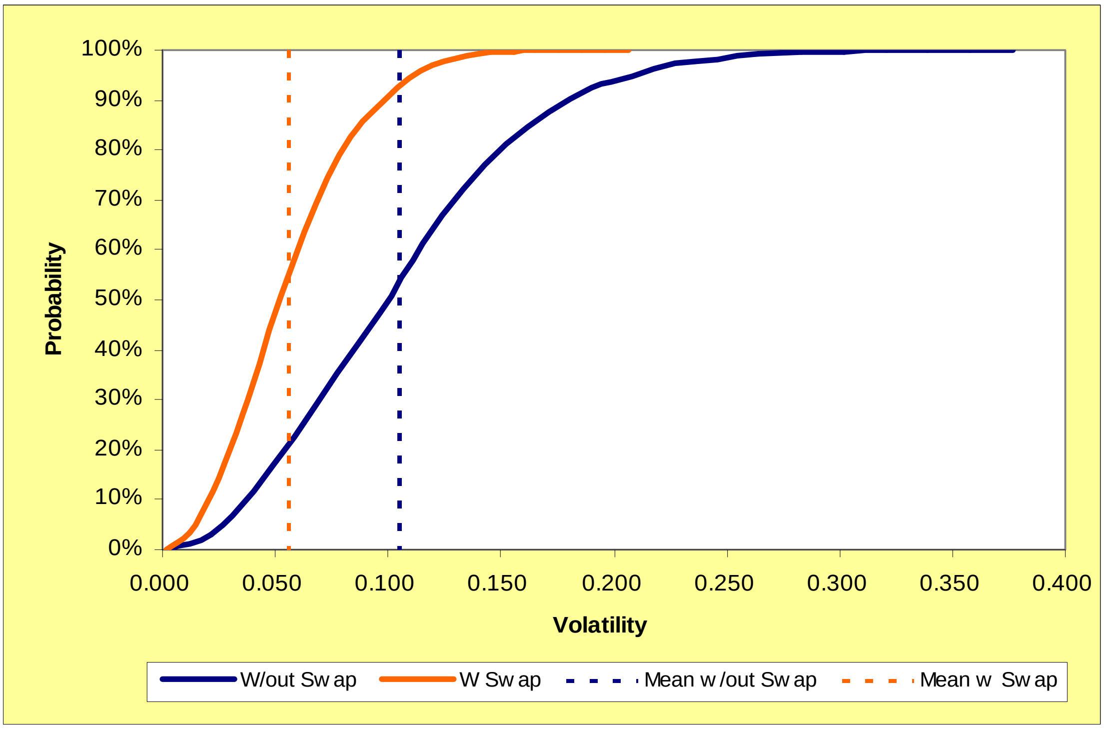


Figure 3-17: The Return Volatility Distribution for 500-Property Portfolio in Scenario 2

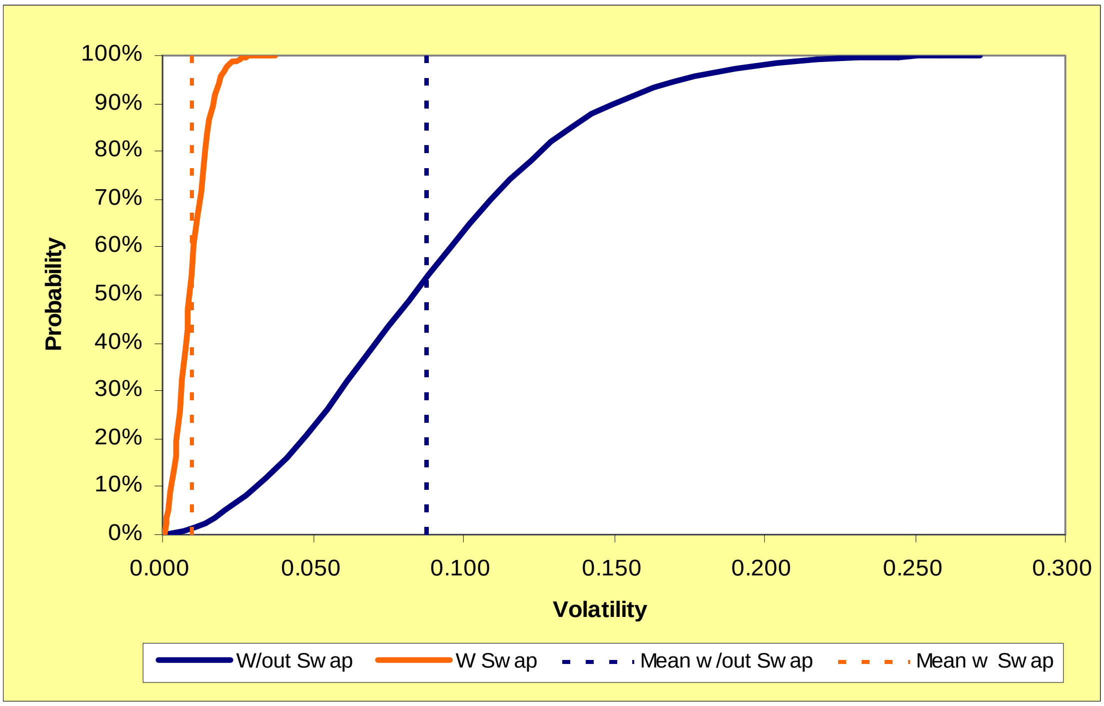


Figure 3-18: The Realized Alpha Distribution for 3-Property portfolio in Scenario 2

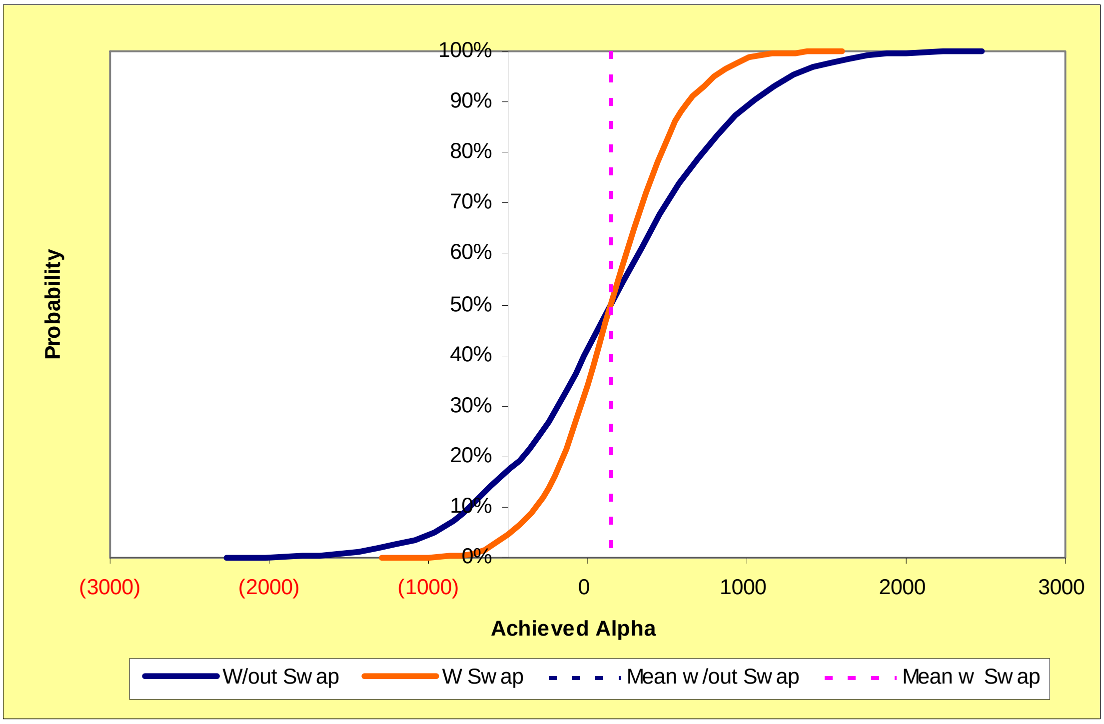
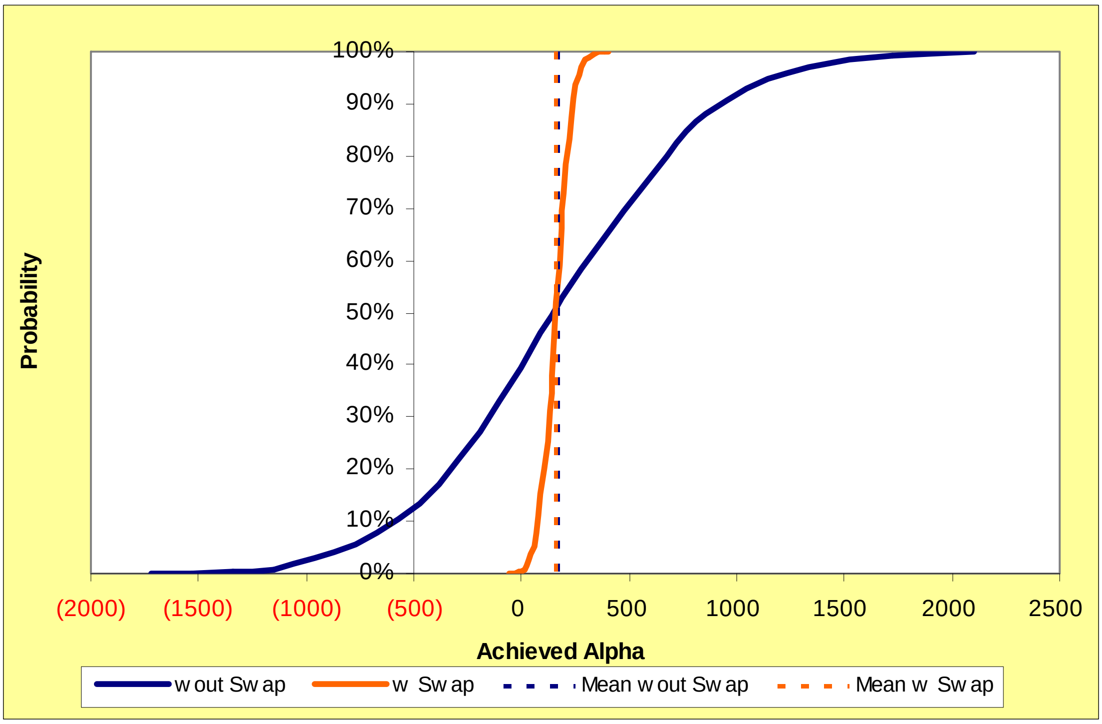


Figure 3-19: The Realized Alpha Distribution for 500-Property portfolio in Scenario 2



(3) *Scenario 3: E[α] =2%; LTV=65%*

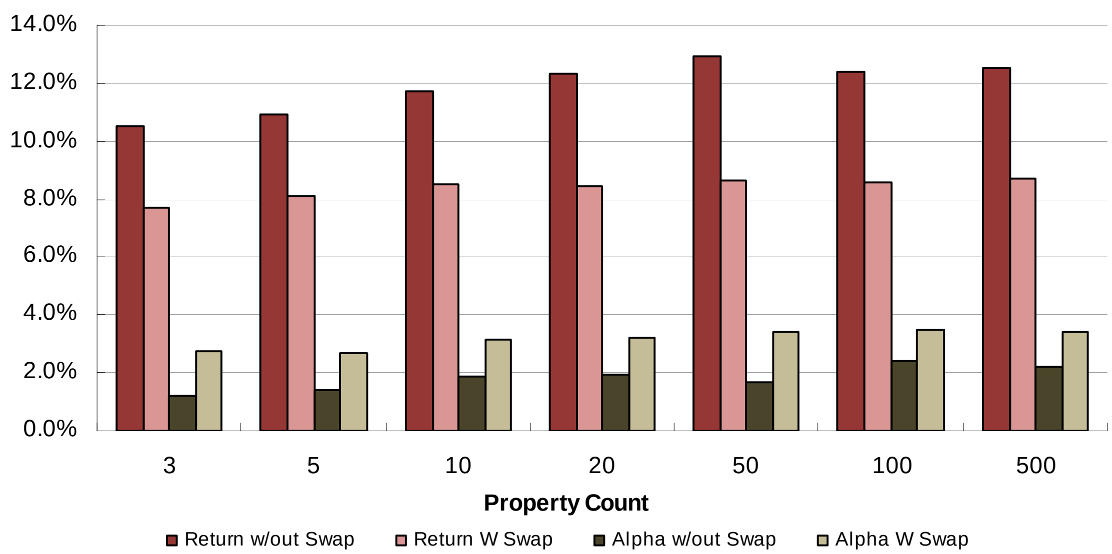
Scenario 3 is designed for α-Harvest hedgers. To represent the general cases, we assume that hedgers take 65% LTV, while keeping a positive alpha constantly. Table 3-6 reports the simulation analysis results in this scenario.

Table 3-6: The Simulation Results in Scenario 3

E[α] =2%;	**LTV=65%**							
		3	5	10	20	50	100	500
Mean Return	W/out swap	10.52%	10.94%	11.69%	12.34%	12.91%	12.40%	12.54%
(%)	W swaps	7.70%	8.14%	8.53%	8.44%	8.67%	8.58%	8.68%
	Difference	-2.82%	-2.80%	-3.17%	-3.90%	-4.24%	-3.82%	-3.85%
Return Volatility	W/out swap	32.68%	30.15%	27.93%	26.71%	26.39%	25.06%	24.86%
(%)	W swaps	16.18%	13.38%	9.87%	7.48%	5.10%	3.82%	2.08%
	Difference	-16.50%	-16.77%	-18.06%	-19.22%	-21.29%	-21.24%	-22.79%
Realized Alpha	W/out swap	122	143	190	193	167	244	218
(bps)	W swaps	275	270	316	320	339	347	344
	Difference	154	127	126	126	172	103	126
Systematic Risk	W/out swap	2.714	2.685	2.667	2.661	2.671	2.693	2.656
	W swaps	0.062	0.069	0.081	0.087	0.089	0.091	0.092
	Difference	(2.653)	(2.616)	(2.586)	(2.574)	(2.581)	(2.603)	(2.564)

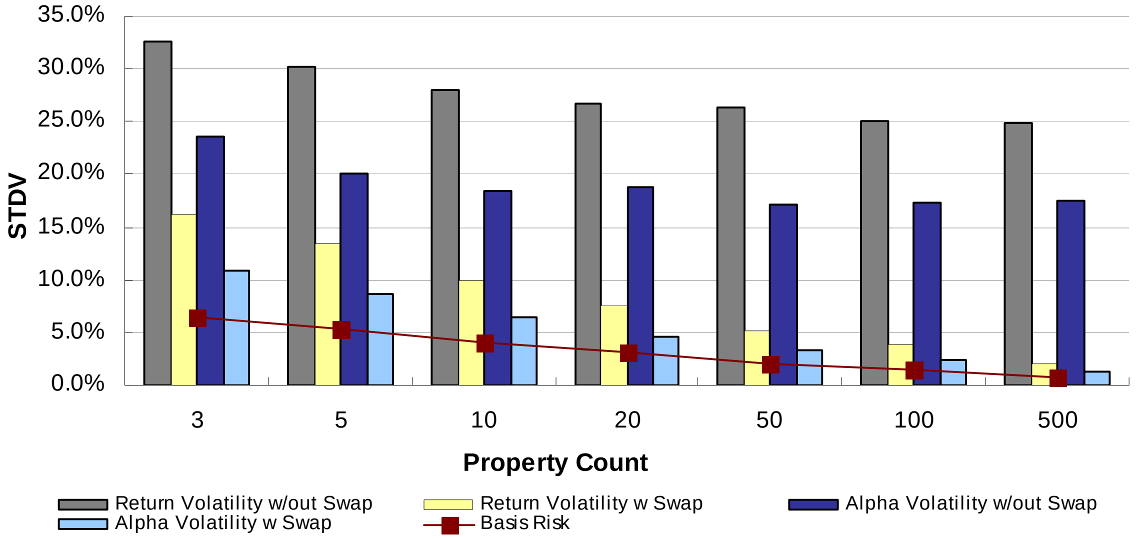
As is shown in the table above, the leverage magnifies return, volatility and alpha. The portfolio average returns are levered up from 8.70% in Scenario 2 to 11.90% in this scenario. Hedging, however, reduces the average portfolio return from 11.90% before the hedging to 8.39%. The systematic risks before hedging are identical in the first two scenarios, but in Scenario 3 they are magnified by 2.7 times after the use of leverage. However, the hedging effectively eliminates the systematic risk to near zero for portfolios of any sizes. Without the systematic risk, the portfolio return premiums mainly come from the alpha expectation. Figure 3-20 shows that the average alpha realization in this scenario is scaled up about 1.73 times from 183 basis points to 316 basis points. This to some extent compensates the reduction of return caused by hedging. It seems likely that the alphas of small portfolios are scaled up more than those of big portfolios but not by any clear rule. The detailed return and alpha distributions on the smallest portfolio (3 properties) and the biggest portfolio (500 properties) can be seen in Figures 4-22 and 4-23.

Figure 3-20: The Return and Alpha Realization in Scenario 3



As it does to the return, the leverage increases the portfolios' volatility. Ranging from 32.68% to 24.86%, the volatility of returns has a mean of 27.68% before hedging; after that, the average volatility drops to 8.27%. Figure 3-21 shows an obviously linear decrease on return volatility after hedging, with the increase on portfolio sizes. The 3-property portfolio has 16.18% volatility after hedging, but the big portfolio, such as the 500-property portfolio, has a quite low volatility of 2.08%. This is because big portfolios carry the significantly lower basis risk (specific risk), which is the major composition of portfolio volatility after hedging. From comparison between Scenarios 2 and 3, we find that the return volatilities both before and after hedging in Scenario 3 are nearly 3 times (close to the Leverage Ratio) in Scenario 2. This magnification demonstrates that hedging reduces the systematic risk to near zero, but does not affect the basis risk or idiosyncratic risk. Leverage scales up the basis risk and thus leaves the portfolio volatilities after hedging multiplied. Figure 3-24 to 3-27 show the clear distribution changes in volatility of the smallest and the biggest portfolios.

Figure 3-21: The Return and Alpha Volatility in Scenario 3



Scenario 3 unveils that although the leverage magnifies the portfolio volatility, hedging eliminates the systematic risk as expected. However, the magnification on the basis risks cannot be offset by hedging. The scaled-up basis risk increases the portfolios' volatility and the alpha realization.

Considering the case of α-Usage hedgers (those who use debts), we see the increase of alpha realization after hedging. However, the reduction of portfolio return cannot be neglected. By removing the magnified systematic risk, the portfolio returns are significantly reduced. But hedging cannot take away the magnified specific risk, which leaves higher portfolio volatility as well as higher alpha achievements to hedgers.

α -Usage hedgers attempt to obtain a magnified alpha and to restrain the magnitude of portfolio risks. Hedging essentially helps realize this goal. For big portfolios with small specific risks, the reduction of returns trades an alpha achievement with less volatility than the market. Small portfolios, however, have to take the significantly high volatility associated with the positive alpha achievement. Is hedging a good deal? The answers could be different by different hedgers.

Figure 3-22: The G-mean of Return Distribution for 3-Property Portfolio in Scenario 3

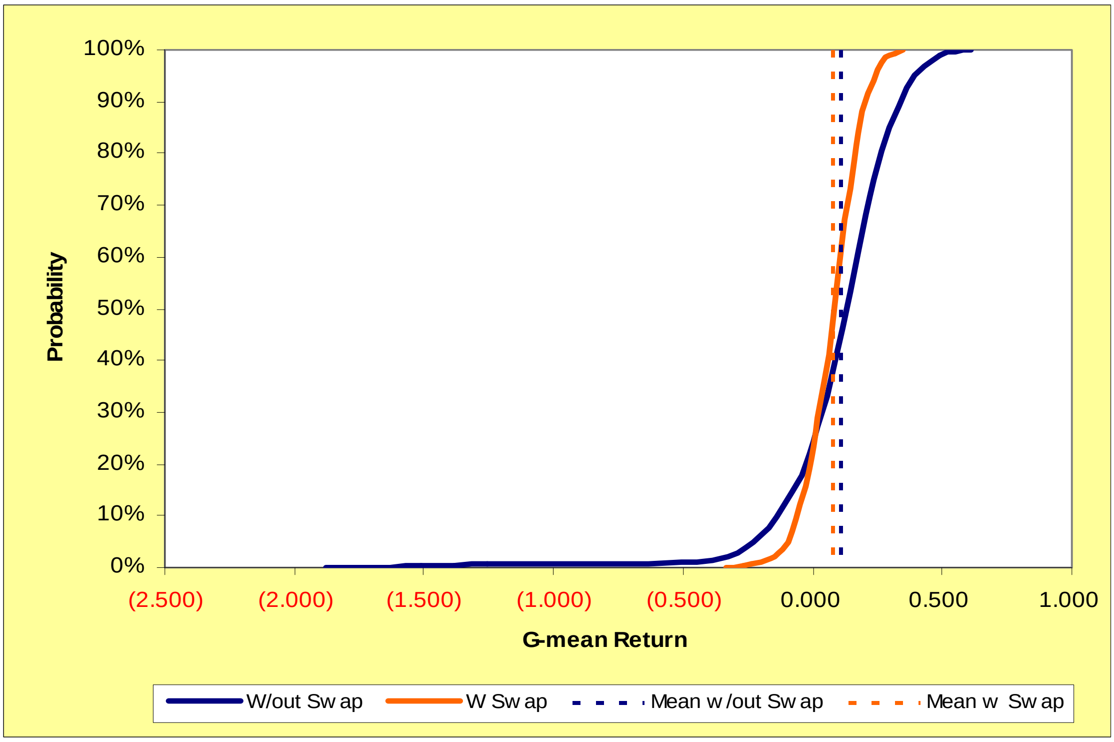


Figure 3-23: The G-mean of Return Distribution for 500-Property Portfolio in Scenario 3

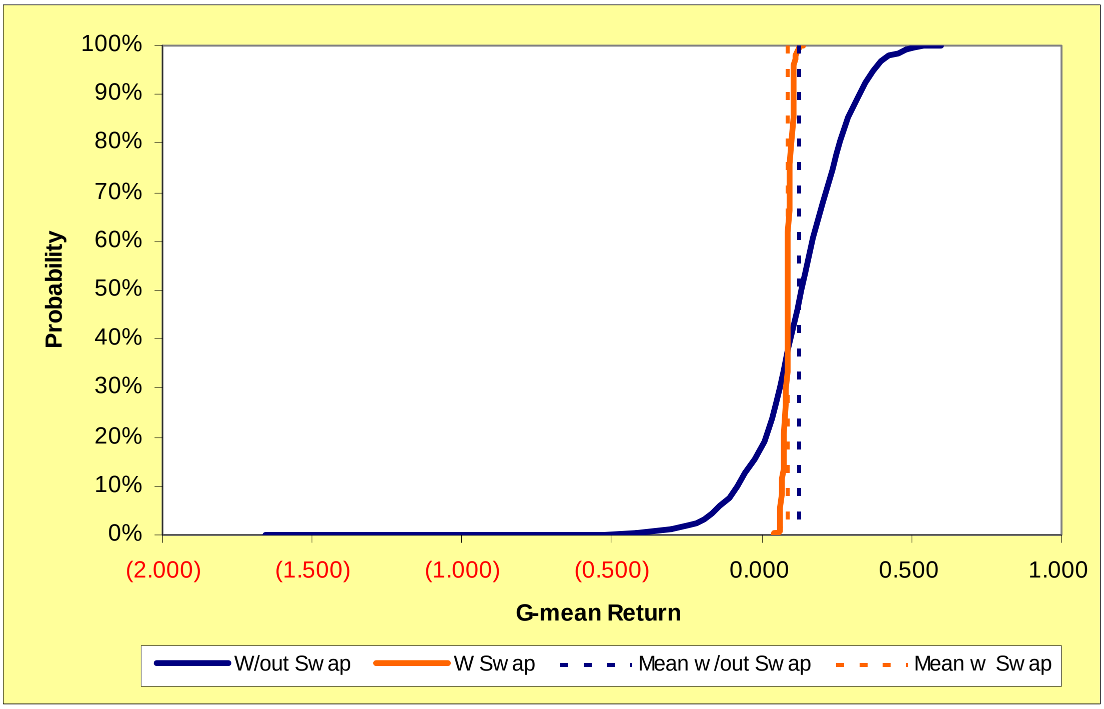


Figure 3-24: The Return Volatility Distribution for 3-Property Portfolio in Scenario 3

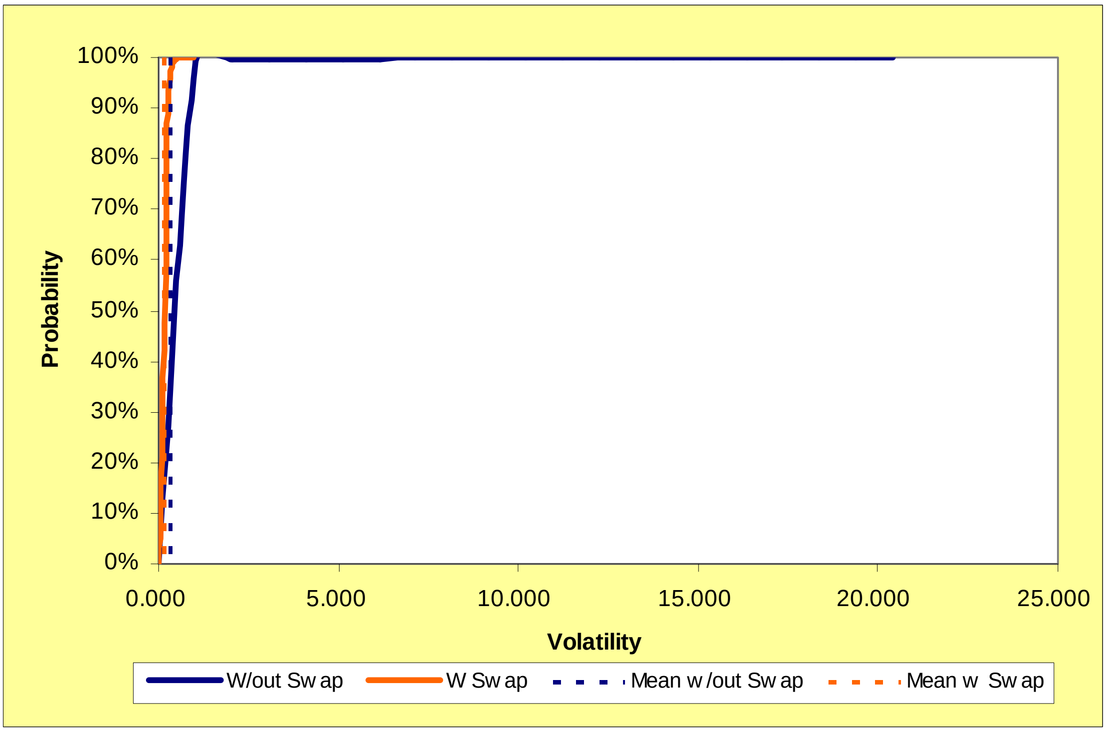


Figure 3-25: The Return Volatility Distribution for 500-Property Portfolio in Scenario 3

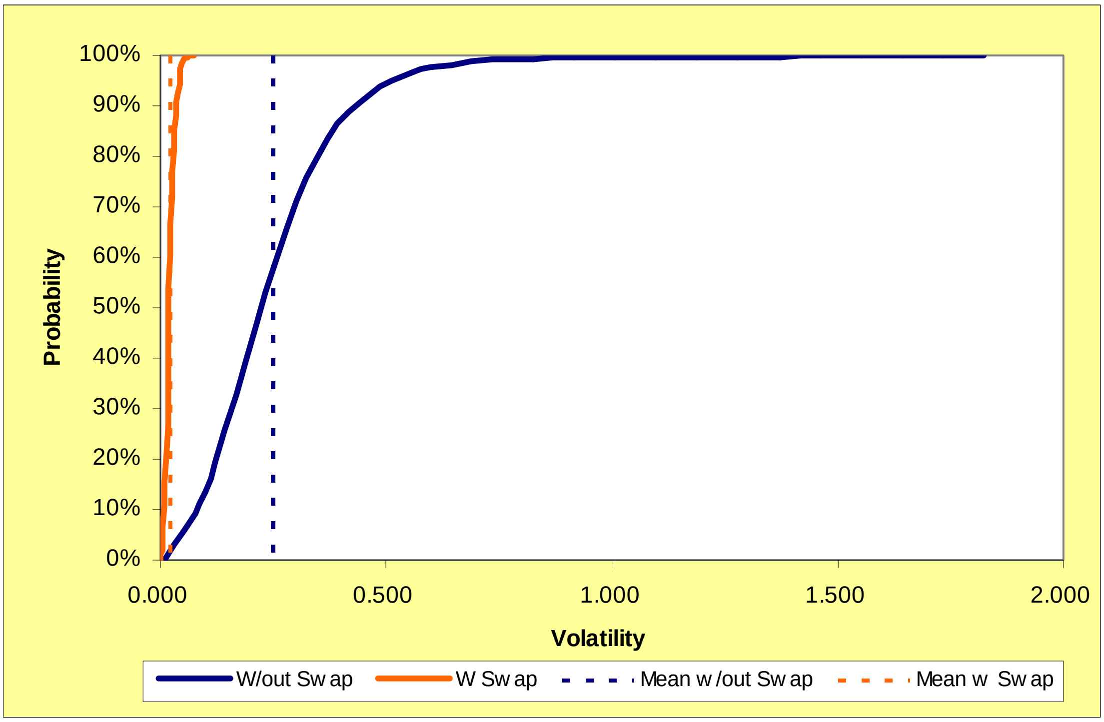


Figure 3-26: The Realized Alpha Distribution for 3-Property Portfolio in Scenario 3

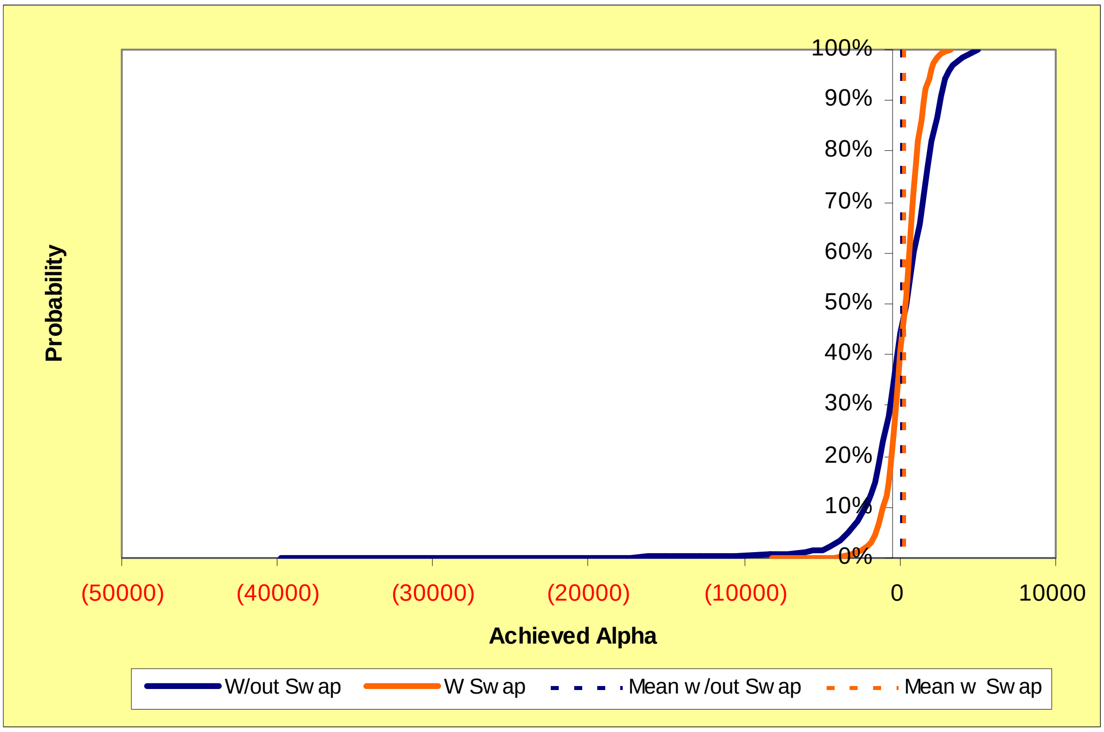
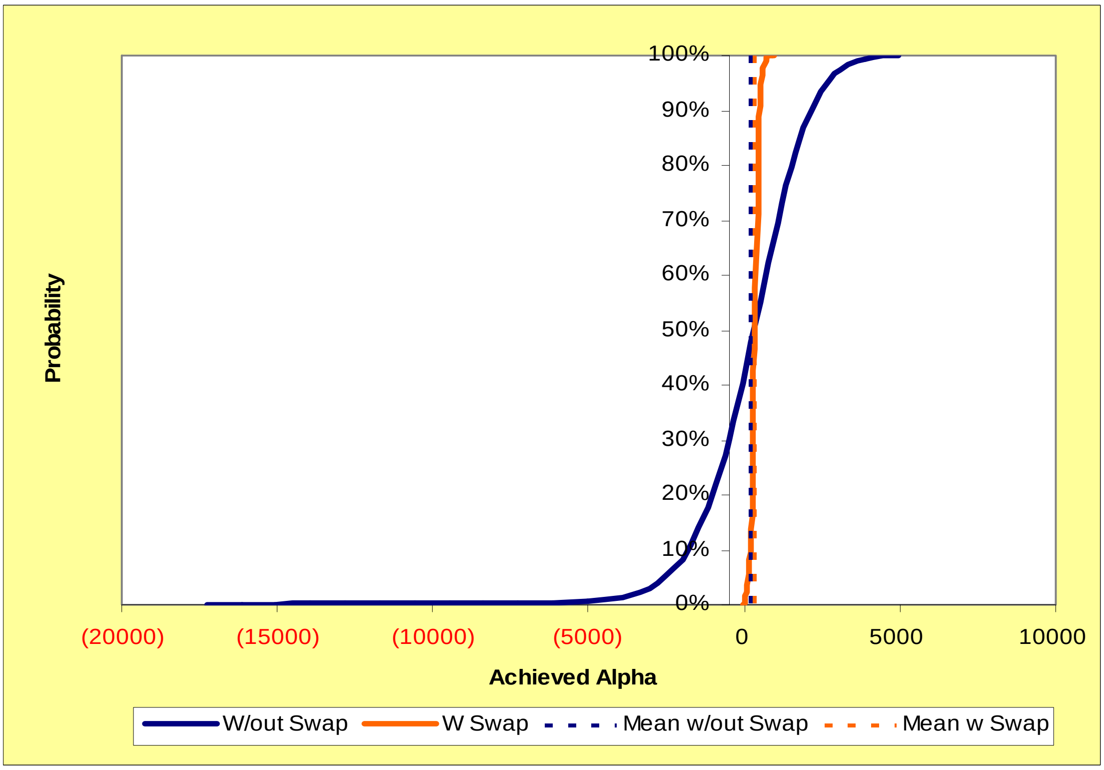


Figure 3-27: The Realized Alpha Distribution for 500-Property Portfolio in Scenario 3



Chapter 4: Conclusion and Further Research

4.1. Study Summary and Conclusion

This thesis identifies how the basis risk influences the effectiveness of hedging. Through the analysis of characteristics of basis risk, the study makes its first major point: different types of hedgers have different concerns about basis risks. The thesis splits hedgers into two fundamental categories: β-Avoidance hedgers and α-Usage hedgers, and each category can be further sub-divided into two uses.

β -Avoidance hedgers can be sub-divided into portfolio-rebalance hedgers and temporary-defensive hedgers; α-Usage hedgers can be sub-divided into α-Transport hedgers and α-Harvest hedgers. By analyzing each of these four sub-uses, this study points out their different standpoints to hedging and to basis risks respectively. β -Avoidance hedgers attempt to avoid systematic (market) risk and do not care much about the basis risk or idiosyncratic risk. α -Usage hedgers want to hedge away the systematic risk but have to keep the basis risk along with the positive alpha achievement. Both hedgers need to deal with the volatility caused by the basis risk in any case.

Using the basis risk (tracking error) report from the 2007 IPF study, this thesis applies Monte Carlo simulation to quantify basis risk's effect on the hedging. The results demonstrate that hedging first eliminates the systematic risk no matter what sizes the portfolios have and whether the portfolios employ leverage. But the volatility left by the basis risk after hedging is considerable, especially for small portfolios (with fewer properties). Second, hedgers without an alpha expectation have quite low returns. Adding alpha expectation could increase the return to certain extent. Third, when leverage is involved, hedgers do achieve higher return and alpha realization, but the volatility of both returns and alphas are also significantly magnified. The small-portfolio hedgers have to withstand significantly high volatility after hedging. Overall, hedging uses the return premiums to exchange low risks. Whether it is a good deal needs to be considered based on comparison between portfolio volatility and returns before and after hedging.

4.2. The Scope of Further Study

This study suggests two areas for further studies. First, this study only considers the basis risk and hedging, but sub-market risk also deserves attentions and researches. Caused by the illiquidity of sub-index in current market, sub-market risk determines how much systematic risk hedging can take away. A further study could be undertaken to measure the sub-market risk and test its impact on hedging.

Second, further studies might be built upon the limitations of the basis risk report from the IPF study. The IPD property data used to calculate basis risks only spanned from 1994 to 2004. These ten years were purely a period of market upswing and do not cover a whole real estate cycle. It is important to realize that a big market crash like the recent downturn can reduce the basis risk and make hedging more valuable and feasible. Therefore, a further study of basis risks during a market downturn could be useful for hedgers.

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Appendix A: The Volatility Reports of Monte Carlo Simulation

		Return STDV			Volatility STDV			Alpha STDV		
		W/out Swap	W swaps	Difference	W/out Swap	W swaps	Difference	W/out Swap	W swaps	Difference
α=0	**3**	6.67%	3.91%	-2.76%	5.48%	2.98%	-2.49%	7.05%	3.80%	-3.25%
LTV=0	**5**	6.67%	3.85%	-2.82%	5.45%	3.00%	-2.45%	6.78%	3.82%	-2.96%
	10	6.27%	2.42%	-3.86%	4.92%	1.88%	-3.04%	6.12%	2.41%	-3.71%
	20	6.23%	1.83%	-4.39%	4.91%	1.43%	-3.48%	6.02%	1.77%	-4.25%
	50	5.99%	1.29%	-4.70%	4.64%	0.99%	-3.65%	5.81%	1.24%	-4.57%
	100	5.89%	0.99%	-4.90%	4.71%	0.76%	-3.95%	5.72%	0.94%	-4.78%
	500	5.89%	0.57%	-5.32%	4.67%	0.45%	-4.22%	5.90%	0.57%	-5.33%
α=2	**3**	6.87%	3.78%	-3.09%	5.58%	2.97%	-2.60%	6.83%	3.79%	-3.04%
LTV=0	**5**	6.55%	3.20%	-3.35%	5.29%	2.47%	-2.82%	6.52%	3.15%	-3.38%
	10	6.25%	2.46%	-3.79%	4.97%	1.90%	-3.06%	6.33%	2.41%	-3.91%
	20	6.11%	1.89%	-4.22%	4.95%	1.48%	-3.47%	5.98%	1.87%	-4.11%
	50	6.06%	1.29%	-4.77%	4.77%	1.05%	-3.72%	5.89%	1.29%	-4.60%
	100	5.81%	1.02%	-4.79%	4.63%	0.79%	-3.83%	6.01%	1.00%	-5.02%
	500	5.66%	0.64%	-5.02%	4.61%	0.53%	-4.08%	5.92%	0.63%	-5.28%
α=2	**3**	23.42%	10.61%	-12.80%	58.78%	8.63%	-50.15%	21.88%	10.43%	-11.45%
LTV=65%	**5**	21.33%	8.86%	-12.47%	34.48%	7.17%	-27.32%	20.16%	8.57%	-11.59%
	10	18.16%	6.32%	-11.84%	17.03%	5.30%	-11.73%	18.44%	6.36%	-12.08%
	20	16.68%	4.94%	-11.74%	21.15%	3.88%	-17.27%	18.83%	4.69%	-14.14%
	50	16.00%	3.34%	-12.66%	20.10%	2.72%	-17.38%	17.10%	3.31%	-13.79%
	100	15.99%	2.50%	-13.49%	14.88%	2.04%	-12.84%	17.40%	2.44%	-14.96%
	500	16.41%	1.33%	-15.07%	15.52%	1.09%	-14.43%	17.52%	1.33%	-16.19%

Appendix B: 3-Property Portfolio Simulation Results

Scenario 1: E[α]=0; LTV=0

		G-Mean	Volatility	Alpha
wout Swap or Debt	**Mean**	6.78%	10.56%	-47
	Std.Dev	6.67%	5.48%	705
	Max	32.12%	35.89%	2582
	Min	-15.36%	0.13%	-2454
w Swap	**Mean**	4.56%	5.66%	-44
	Std.Dev	3.91%	2.98%	380
	Max	18.94%	17.05%	1538
	Min	-13.09%	0.03%	-1128

Scenario 2: E[α]=2%; LTV=0

		G-Mean	Volatility	Alpha
wout Swap or Debt	**Mean**	8.51%	10.50%	151
	Std.Dev	6.87%	5.58%	683
	Max	29.87%	37.66%	2472
	Min	-13.47%	0.28%	-2266
w Swap	**Mean**	6.66%	5.61%	152
	Std.Dev	3.78%	2.97%	379
	Max	19.17%	20.66%	1592
	Min	-5.73%	0.16%	-1294

Scenario 3: E[α]=2%; LTV=65%

		G-Mean	Volatility	Alpha
wout Swap or Debt	**Mean**	10.52%	32.68%	122
	Std.Dev	22.30%	64.34%	2365
	Max	61.20%	2042.04%	5071
	Min	-188.11%	1.12%	-39711
w Swap	**Mean**	7.70%	16.18%	275
	Std.Dev	10.39%	9.08%	1078
	Max	35.06%	95.15%	3244
	Min	-33.67%	0.18%	-8199

Appendix C: 5-Property Portfolio Simulation Results

Scenario 1: E[α]=0; LTV=0

		G-Mean	Volatility	Alpha
wout Swap or Debt	**Mean**	6.44%	10.56%	-23
	Std.Dev	6.67%	5.45%	678
	Max	32.85%	35.84%	2404
	Min	-16.88%	0.12%	-2466
w Swap	**Mean**	4.53%	5.74%	-46
	Std.Dev	3.85%	3.00%	382
	Max	16.97%	19.96%	1155
	Min	-7.84%	0.10%	-1192

Scenario 2: E[α]=2%; LTV=0

		G-Mean	Volatility	Alpha
wout Swap or Debt	**Mean**	8.40%	10.22%	152
	Std.Dev	6.55%	5.29%	652
	Max	29.02%	32.55%	2301
	Min	-15.61%	0.07%	-1944
w Swap	**Mean**	6.64%	4.64%	154
	Std.Dev	3.20%	2.47%	315
	Max	17.37%	15.44%	1347
	Min	-3.90%	0.06%	-870

Scenario 3: E[α]=2%; LTV=65%

		G-Mean	Volatility	Alpha
wout Swap or Debt	**Mean**	10.94%	30.15%	143
	Std.Dev	21.33%	34.48%	2016
	Max	62.72%	1268.11%	4792
	Min	-171.74%	0.67%	-18289
w Swap	**Mean**	8.14%	13.38%	270
	Std.Dev	8.86%	7.17%	857
	Max	32.28%	45.73%	2895
	Min	-26.74%	0.79%	-3375

Appendix D: 10-Property Portfolio Simulation Results

Scenario 1: E[α]=0; LTV=0

		G-Mean	Volatility	Alpha
wout Swap or Debt	**Mean**	6.53%	9.34%	-37
	Std.Dev	6.27%	4.92%	612
	Max	29.68%	29.86%	2557
	Min	-12.87%	0.13%	-2148
w Swap	**Mean**	4.75%	3.62%	-37
	Std.Dev	2.42%	1.88%	241
	Max	14.13%	12.37%	824
	Min	-3.36%	0.05%	-912

Scenario 2: E[α]=2%; LTV=0

		G-Mean	Volatility	Alpha
wout Swap or Debt	**Mean**	8.92%	9.34%	191
	Std.Dev	6.25%	4.97%	633
	Max	31.83%	30.59%	2304
	Min	-12.56%	0.35%	-1990
w Swap	**Mean**	6.73%	3.66%	162
	Std.Dev	2.46%	1.90%	241
	Max	14.93%	12.63%	1017
	Min	-2.64%	0.06%	-607

Scenario 3: E[α]=2%; LTV=65%

		G-Mean	Volatility	Alpha
wout Swap or Debt	**Mean**	11.69%	27.93%	190
	Std.Dev	18.16%	17.03%	1844
	Max	64.44%	205.00%	5159
	Min	-159.69%	0.32%	-18972
w Swap	**Mean**	8.53%	9.87%	316
	Std.Dev	6.32%	5.30%	636
	Max	32.62%	34.57%	2356
	Min	-17.79%	0.28%	-2390

Appendix E: 20-Property Portfolio Simulation Results

Scenario 1: E[α]=0; LTV=0

		G-Mean	Volatility	Alpha
wout Swap or Debt	**Mean**	6.77%	9.29%	-31
	Std.Dev	6.23%	4.91%	602
	Max	31.58%	29.64%	2052
	Min	-11.68%	0.22%	-2175
w Swap	**Mean**	4.70%	2.71%	-42
	Std.Dev	1.83%	1.43%	177
	Max	10.67%	8.29%	633
	Min	-1.09%	0.11%	-609

Scenario 2: E[α]=2%; LTV=0

		G-Mean	Volatility	Alpha
wout Swap or Debt	**Mean**	9.04%	9.46%	151
	Std.Dev	6.11%	4.95%	598
	Max	29.89%	31.93%	2282
	Min	-10.50%	0.16%	-1857
w Swap	**Mean**	6.72%	2.79%	159
	Std.Dev	1.89%	1.48%	187
	Max	12.71%	10.03%	738
	Min	-0.41%	0.05%	-478

Scenario 3: E[α]=2%; LTV=65%

		G-Mean	Volatility	Alpha
wout Swap or Debt	**Mean**	12.34%	26.71%	193
	Std.Dev	16.68%	21.15%	1883
	Max	55.75%	688.19%	5455
	Min	-171.48%	0.47%	-16429
w Swap	**Mean**	8.44%	7.48%	320
	Std.Dev	4.94%	3.88%	469
	Max	25.10%	23.83%	1755
	Min	-8.50%	0.22%	-1091

Appendix F: 50-Property Portfolio Simulation Results

Scenario 1: E[α]=0; LTV=0

		G-Mean	Volatility	Alpha
wout Swap or Debt	**Mean**	6.53%	8.92%	-51
	Std.Dev	5.99%	4.64%	581
	Max	25.30%	30.70%	1946
	Min	-13.36%	0.20%	-1917
w Swap	**Mean**	4.69%	1.92%	-42
	Std.Dev	1.29%	0.99%	124
	Max	10.05%	6.06%	423
	Min	1.08%	0.04%	-535

Scenario 2: E[α]=2%; LTV=0

		G-Mean	Volatility	Alpha
wout Swap or Debt	**Mean**	8.69%	9.00%	167
	Std.Dev	6.06%	4.77%	589
	Max	31.63%	27.06%	2237
	Min	-16.61%	0.13%	-1921
w Swap	**Mean**	6.74%	2.00%	164
	Std.Dev	1.29%	1.05%	129
	Max	11.26%	6.70%	572
	Min	2.14%	0.04%	-224

Scenario 3: E[α]=2%; LTV=65%

		G-Mean	Volatility	Alpha
wout Swap or Debt	**Mean**	12.91%	26.39%	167
	Std.Dev	16.00%	20.10%	1710
	Max	53.14%	452.24%	4593
	Min	-127.82%	0.39%	-15722
w Swap	**Mean**	8.67%	5.10%	339
	Std.Dev	3.34%	2.72%	331
	Max	20.41%	16.26%	1492
	Min	-4.07%	0.27%	-776

Appendix G: 100-Property Portfolio Simulation Results

Scenario 1: E[α]=0; LTV=0

		G-Mean	Volatility	Alpha
wout Swap or Debt	**Mean**	6.62%	9.14%	-16
	Std.Dev	5.89%	4.71%	572
	Max	25.42%	26.59%	1907
	Min	-10.74%	0.12%	-2040
w Swap	**Mean**	4.69%	1.42%	-39
	Std.Dev	0.99%	0.76%	94
	Max	8.43%	4.91%	331
	Min	1.96%	0.02%	-289

Scenario 2: E[α]=2%; LTV=0

		G-Mean	Volatility	Alpha
wout Swap or Debt	**Mean**	8.55%	9.18%	160
	Std.Dev	5.81%	4.63%	601
	Max	28.53%	31.13%	2522
	Min	-14.79%	0.37%	-1983
w Swap	**Mean**	6.76%	1.53%	161
	Std.Dev	1.02%	0.79%	100
	Max	10.32%	5.05%	539
	Min	2.99%	0.02%	-139

Scenario 3: E[α]=2%; LTV=65%

		G-Mean	Volatility	Alpha
wout Swap or Debt	**Mean**	12.40%	25.06%	244
	Std.Dev	15.99%	14.88%	1740
	Max	56.89%	187.40%	4967
	Min	-110.55%	0.31%	-17918
w Swap	**Mean**	8.58%	3.82%	347
	Std.Dev	2.50%	2.04%	244
	Max	17.21%	12.31%	1193
	Min	0.72%	0.06%	-527

Appendix H: 500-Property Portfolio Simulation Results

Scenario 1: E[α]=0; LTV=0

		G-Mean	Volatility	Alpha
wout Swap or Debt	**Mean**	6.81%	8.82%	-26
	Std.Dev	5.89%	4.67%	590
	Max	32.90%	29.98%	2077
	Min	-12.36%	0.27%	-2169
w Swap	**Mean**	4.70%	0.85%	-38
	Std.Dev	0.57%	0.45%	57
	Max	6.58%	2.75%	200
	Min	2.89%	0.02%	-219

Scenario 2: E[α]=2%; LTV=0

		G-Mean	Volatility	Alpha
wout Swap or Debt	**Mean**	8.76%	8.78%	169
	Std.Dev	5.66%	4.61%	592
	Max	28.97%	27.14%	2102
	Min	-10.86%	0.04%	-1724
w Swap	**Mean**	6.72%	0.98%	160
	Std.Dev	0.64%	0.53%	63
	Max	8.83%	3.72%	406
	Min	4.52%	0.04%	-56

Scenario 3: E[α]=2%; LTV=65%

		G-Mean	Volatility	Alpha
wout Swap or Debt	**Mean**	12.54%	24.86%	218
	Std.Dev	16.41%	15.52%	1752
	Max	59.76%	182.40%	4974
	Min	-165.75%	0.86%	-17267
w Swap	**Mean**	8.68%	2.08%	344
	Std.Dev	1.33%	1.09%	133
	Max	13.81%	7.50%	935
	Min	3.85%	0.02%	-57