A Study on Real Estate Derivatives

By

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Submitted to the Department of Architecture and the Department of Urban Studies and Planning in Partial Fulfillment of the Requirements for the Degree of Master of Science in Real Estate Development

at the

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Abstract

All major asset classes including stocks and bonds have a well developed derivative market. Derivatives enable counterparties to reflect a view on a particular market, without having to trade the underlying asset. This seems to be a particularly appealing feature for real estate, an industry characterized by high transaction cost, long lead transaction time and lack of short-selling mechanism. Still, real estate remains the last major asset class without a liquid derivative market until recently when Credit Suisse began to offer swaps on the NCREIF Property Index (NPI) in the U.S. early this year following the UK's ten-year endeavor in developing real estate derivative market.

The purpose of this thesis is two fold. First, in chapter one and two, we would like to explain what real estate derivatives are, how they work and why they can be beneficial to investors. Second, we are introducing some practical tools investors may use in evaluating and trading real estate derivatives. In chapter three, we are introducing three forecasting models on the NCREIF Property Index. In chapter four, we are expanding Prof. David Geltner's pricing methods on real estate index capital return swap to the NPI total return swap and property type total return swap. These pricing methods present a basic foundation for investors to price all three types of swap currently being offered by Credit Suisse.

In our study, we find that derivatives can provide numerous benefits to real estate investors including low transaction cost, quick execution and short-selling mechanism. These benefits in turn can help investors implement various strategies including hedging against market risk, asset allocation, sector rebalancing, international diversification and portable Alpha. Our research on UK's experience in real estate derivatives as well as our investor survey results in the U.S. and the UK lead us to believe that further initiative and pioneering efforts are critical for the development of the real estate derivatives market. By presenting this study on index forecasting models and pricing methodologies, we hope to increase the awareness and comfort level of investors and thus encourage the proliferation of real estate derivatives.

Thesis Supervisor: David M. Geltner
Title: Professor of Real Estate Finance

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Finally, we are forever indebted to our family for their understanding, endless patience, and encouragement when it was most required.

Chapter One: Overview of Real Estate Derivatives

Overview

A derivative is an asset that derives its value from an underlying index or asset. Some of the most well-known derivatives like stock options, commodity futures and interest rate swaps have been widely used and traded for years. Benefits of derivatives are evident: investors can execute hedging, asset allocation and portfolio rebalancing quicker and cheaper with derivatives, and the asset market as a whole is more liquid and efficient thanks to derivatives. While private real estate[1] has been attracting increasingly large amount of capital in the last few years, applicable derivative products and a liquid derivative market could be the last piece missing for it to become a truly major asset class.[2]

Real estate derivatives discussed in this thesis are all in the form of swaps written on a commercial real estate investment performance index: the NCREIF Property Index (NPI) in the U.S. or the Investment Property Databank (IPD) index in the UK[3]. In the U.S., Credit Suisse has been granted two-year exclusive license to use the NCREIF indices in creating and offering the NPI derivatives. In this chapter, we are introducing the three real estate derivative products currently available in the U.S., explaining their benefits and applications, and finally briefly

[1] Private real estate is defined as commercial properties traded in the private market as opposed those traded on the stock exchanges in the forms of REITs.

[2] While it is not uncommon for a REIT (Real Estate Investment Trust) to have options, studies shows very low correlation between private real estate and public real estate (REITs) which behaves more like small-cap stocks.

[3] NPI is a real estate investment performance index that tracks institutionally-owned private commercial real estate in U.S., and IPD is its counterpart in the UK.

discussing UK's experience in developing its real estate derivative market in the hope of gaining insights on the formation of a similar market in the U.S.

Real Estate Derivatives Products

The three real estate derivative products being offered by Credit Suisse include:

- Price return swaps on the capital value return component of the NPI[4]
- Property type swaps for the total return (capital value + income) on the NPI property type sub-indices.
- Total return swap on the NPI total return (capital value + income)

These swaps are all "contracts of differences": no cash is exchanged upfront; rather, at the end of each quarter over the term of the swap contract, cash payments based on a notional amount are netted and transferred from one side to the other depending on the relative performance of the NPI versus the other predetermined return measure (fixed rate or LIBOR + spread). At the each cash settlement, long side's gain/loss is short side's loss/gain.

Capital Value Return Swap

Capital value return swap is a transaction where the long side receives the quarterly capital value return component of the NPI (price appreciation) from the short side and in return pays a predetermined fixed spread to the short side.

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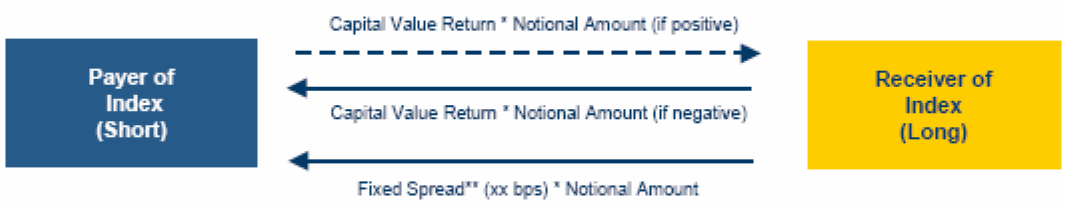
[4] The quarterly NPI total return is the sum of income return and capital value return. Income return is the similar concept of dividend yield for stocks and capital value return is the same concept of stock's price appreciation. More detailed explanation on the NPI will be discussed in Chapter III.

Exhibit I-1. Capital Value Return Swap



For example, a swap contract is written where the long side will receive the NPI capital value return in exchange for 8% per annum (2% quarterly) on a notional value of $10 million. If at the end of first quarter, the NPI appreciates by 2.5%, the long side will receive $250,000 ($10 million*2.5%) and pay $200,000 ($10 million*2%), resulting in a net cash flow of $50,000 ($10 million*(2.5%-2%)) from the short side to the long side.

Exhibit I-2. Cash positions of a hypothetical 1 year NPI capital value return swap

Capital Value Return Swap

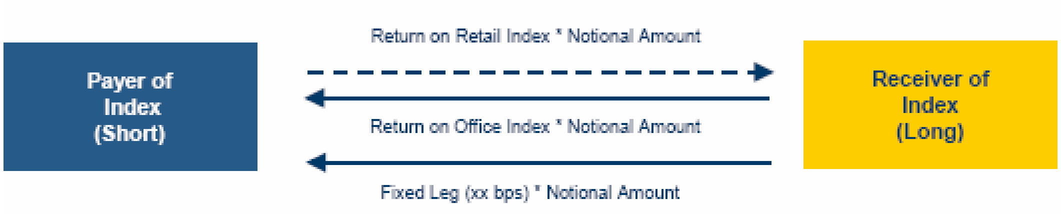
Notional amount	$10,000,000			
Fixed spread	8%			
Term	1 year			
Quarter	1	2	3	4
NPI capital value return	2.50%	2.00%	1.75%	-0.50%
Fixed spread	2.00%	2.00%	2.00%	2.00%
Long side cash flows (receives NPI capital value return, pays fixed spread)				
NPI capital value return	$250,000	$200,000	$175,000	-$50,000
Fixed spread	-$200,000	-$200,000	-$200,000	-$200,000
Net cashflows	**$50,000**	**$0**	**-$25,000**	**-$250,000**
Short side cash flows (receive fixed spread, pay NPI capital value return)				
Fixed spread	$200,000	$200,000	$200,000	$200,000
NPI capital value return	-$250,000	-$200,000	-$175,000	$50,000
Net cashflows	**-$50,000**	**$0**	**$25,000**	**$250,000**

In general, the quarterly net cash flow for the long side is notional amount * (NPI capital value return – fixed spread); the quarterly net cash flow for the short side is notional amount * (fixed spread – NPI capital value return). The net cash flow can be positive, negative or zero depending on the performance of the NPI relative to the fixed spread. In a situation where the NPI capital value return is negative, the long side will have to pay the NPI appreciation return in addition to the fixed spread[5]. In certain market conditions, the fixed spread could be negative too, in which case the long side will receive fixed spread rather than paying it. Cash positions for both long and short sides from a hypothetical one year capital return swap is illustrated in the exhibit I-2.

Property Type Total Return Swap

Property type total return swap is a transaction where the long side receives the quarterly total return of one NPI property type sub index from the short side and in return pays the quarterly total return of another NPI property type sub index plus a predetermined fixed spread to the short side.

Exhibit I-3. Property type total return swap



For example, a swap contract is written where the long side will receive the NPI Retail total return and pay the NPI Office total return plus a fixed spread of 2% per annum (0.5% quarterly) on a notional value of $10 million. If at the end of first quarter, the NPI Retail registers a total return of 3% and the NPI Office has a total return of 2%, the long side will receive $300,000 ($10 million*3%) and pay $200,000 ($10 million*2%) plus $50,000 ($10 million*0.5%), resulting in a net cash flow of $50,000 ($10 million*(3%-2%-0.5%)) from the short side to the long side.

[5] Receiving a negative return is equal to paying a positive return

In general, the quarterly net cash flow for the long side is notional amount * (NPI property type #1 total return – NPI property type #2 total return - fixed spread); the quarterly net cash flow for the short side is notional amount * (NPI property type #2 total return + fixed spread – NPI property type #1 total return). The net cash flow can be positive, negative or zero depending on the relative performance of the relevant NPI sub indices. In a situation where the quarterly NPI property type #1 total return is negative, the long side will have to pay rather than receive the NPI property type #1 total return[6]; and in a situation where the quarterly NPI property type #2 total return is negative, the long side will receive rather than pay it. While the direction of cash payment from property type total returns can change depending on whether those returns are positive or negative, the long side will pay the fixed spread regardless. Cash positions for both long and short sides from a hypothetical one year property type total return swap is illustrated as follows:

Exhibit I-4. Cash positions of a hypothetical 1 year NPI property type total return swap

Property Type Total Return Swap

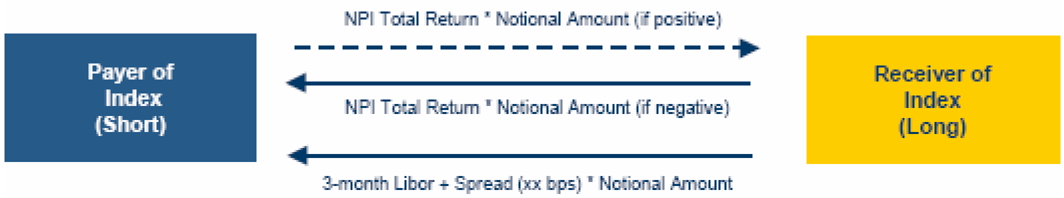
Notional amount		$10,000,000		
Fixed spread of retail over office		2%		
Term		1 year		
Quarter	1	2	3	4
NPI retail total return	3.00%	2.50%	2.75%	-0.25%
NPI office total return	2.00%	2.25%	2.25%	-0.50%
Fixed spread	0.50%	0.50%	0.50%	0.50%
Long side cash flows (receives NPI retail total return, pays NPI office total return and fixed spread)				
NPI retail total return	$300,000	$250,000	$275,000	-$25,000
NPI office total return	-$200,000	-$225,000	-$225,000	$50,000
Fixed spread	-$50,000	-$50,000	-$50,000	-$50,000
Net cashflows	**$50,000**	**-$25,000**	**$0**	**-$25,000**
Short side cash flows (receives NPI office total return and fixed spread, pays NPI retail total return)				
NPI office total return	$200,000	$225,000	$225,000	-$50,000
Fixed spread	$50,000	$50,000	$50,000	$50,000
NPI retail total return	-$300,000	-$250,000	-$275,000	$25,000
Net cashflows	**-$50,000**	**$25,000**	**$0**	**$25,000**

[6] Again, receiving a negative return is equal to paying a positive return

Total Return Swap

Total return swap is a transaction where the long side receives the quarterly NPI total return from the short side and in return pays the 3 month LIBOR plus a predetermined fixed spread to the short side.

Exhibit I-5. NPI total return swap



For example, a swap contract is written where the long side will receive the NPI total return and pay 3 month LIBOR plus a fixed spread of 3% per annum (0.75% quarterly) on a notional value of $10 million. If at the end of first quarter, the NPI total return is 3% and the 3 month LIBOR is 5%[7], the long side will receive $300,000 ($10 million*3%) and pay $125,000 ($10 million*5%/4) plus $75,000 ($10 million*0.75%), resulting in a net cash flow of $100,000 ($10 million*(3%-1.25%-0.75%)) from the short side to the long side.

In general, the quarterly net cash flow for the long side is notional amount*(NPI total return – LIBOR - fixed spread); the quarterly net cash flow for the short side is notional amount*(LIBOR + fixed spread - NPI total return). The net cash flow can be positive, negative or zero depending on the performance of the NPI relative to LIBOR. In a situation where the quarterly NPI total return is negative, the long side will have to pay the NPI total return to the short side in addition

[7] Unlike the NPI returns, 3 month LIBOR is known at the beginning of the quarter and is quoted as annual rate

to the LIBOR and fixed spread payment. Cash positions for both long and short sides from a hypothetical one year total return swap is illustrated as follows:

Exhibit I-6. Cash positions of a hypothetical 1 year NPI total return swap

NPI Total Return Swap				
Notional amount		$10,000,000		
Fixed spread		3%		
Term		1 year		
Quarter	1	2	3	4
NPI total return	3.00%	2.25%	2.00%	-0.25%
LIBOR	1.25%	1.50%	1.50%	1.50%
Fixed spread	0.75%	0.75%	0.75%	0.75%
Long side cash flows (receives NPI retail total return, pays NPI office total return and fixed spread)				
NPI total return	$300,000	$225,000	$200,000	-$25,000
LIBOR	-$125,000	-$150,000	-$150,000	-$150,000
Fixed spread	-$75,000	-$75,000	-$75,000	-$75,000
Net cashflows	**$100,000**	**$0**	**-$25,000**	**-$250,000**
Short side cash flows (receives NPI office total return and fixed spread, pays NPI retail total return)				
LIBOR	$125,000	$150,000	$150,000	$150,000
Fixed spread	$75,000	$75,000	$75,000	$75,000
NPI total return	-$300,000	-$225,000	-$200,000	$25,000
Net cashflows	**-$100,000**	**$0**	**$25,000**	**$250,000**

It is obvious from the above illustration that while parties entering into the swap expect zero or positive cash payoff from the transaction ex-ante, the payoff for either long or short side of the transaction ex-post is a function of two things: 1) the performance of the referenced NPI return[8], 2) the price[9] paid to get that return. In chapter three, we are introducing our predictions on the NPI using our prediction models, and in chapter four, we are going to discuss in detail how to price real estate derivatives.

[8] NPI capital value return, NPI property type sub-indices return or NPI total return respectively for three NPI swaps
[9] Fixed spread, property type total return + spread or LIBOR + spread respectively for three NPI swaps

Benefits and Application of Real Estate Derivatives

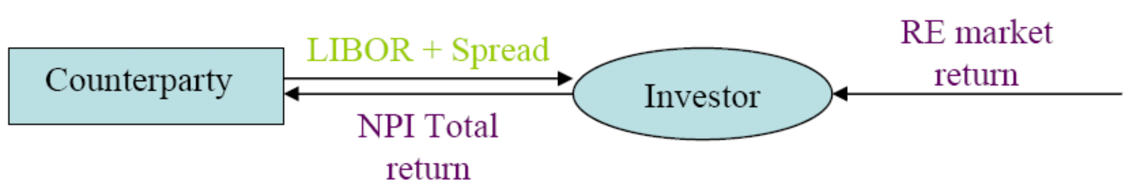
Real estate derivatives provide some obvious and very appealing benefits for an asset class that has been characterized by high transaction cost, long transaction lead time and lack of short-selling mechanism. By eliminating the physical delivery of the asset, many of the negatives in real estate transactions can be mitigated.

First, investing real properties involves large amount of due diligence expenses, management fees and sales commissions. These expenses typically amount to 3-5% of the property value in the U.S. In comparison, real estate derivatives would allow investors to get exposure to a diversified portfolio of commercial real estate at minimum cost (fees to brokers and spreads to investment banks). Second, to acquire a piece of property entails months of due diligence before closing and it would take another few months to sell it when it is decided to dispose the property. The long lead time in acquiring and disposing the physical property largely limits investors' ability to act in anticipation of changes in the marketplace or to respond to current market conditions. Real estate derivatives can speed up this process, achieving a much quicker execution once the liquidity is fully developed in the market. Third, investors can not short physical properties when the market is down and real estate has been an asset class where investors can only long to make money. Real estate derivative provides a short-selling mechanism that would allow investors to hedge or make profit in a declining market. In the following section, we are presenting a few specific applications of real estate derivatives that take advantage of the benefits mentioned above. For simplicity, here we make a few assumptions to ignore some practical problems. For example, although we discuss the discrepancy between the NPI return and the return on the underlying real estate market later in other chapters, here we assume that the NPI return equals to the underlying real estate market return for a given period.

Hedging the real estate market risk

Suppose that an investor who has large exposure in real estate expects the real estate market to slow down. The investor first considers selling some of the properties in the portfolio to reduce the real estate exposure, but soon realizes that the transaction cost as well as the time required for closing the transaction can be very costly. Instead, the investor then looks at the NPI total return swap market where he finds the current price[10] higher than his/her expectation of the real estate market return over the swap contract horizon. As a result, the investor decides to go short in the NPI total return swap and receives LIBOR plus fixed spread while reducing the exposure in real estate by paying the NPI total return to the counterparty. The exhibit I-7 shows the exposure created by this trading strategy.

Exhibit I-7. Hedging the real estate market exposure through the NPI swap



[10] Here the price means the fixed spread (or LIBOR + fixed spread) exchanged for NPI total return

Re-allocation between asset classes

Investor A manages a mixed asset portfolio worth $200 million. The portfolio is composed of equity, fixed income, and real estate with the target allocation level for each asset class 40%, 40%, and 20%, respectively. For the following 6 months, however, the value of the properties significantly appreciate while the equity market turning sluggish. As a result, the total real estate portfolio is now worth $52 mil million with the value of equity portfolio falling down to $75 million. The fixed income portfolio is now valued at $83 million. In order to meet the asset allocation target, investor A decides to use the NPI total return swap and enters into a contract with $10 million notional where s/he pays the NPI total return and receives LIBOR + spread. Also at the same time, investor A increases the equity exposure to $84 million using a new bank loan borrowed at LIBOR, which will then be offset by the LIBOR received from the swap. By using the NPI total return swap,

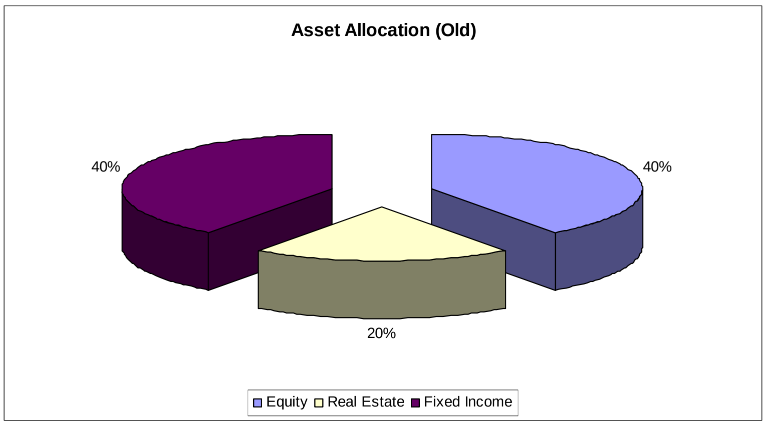


Exhibit I-8. Old asset allocation

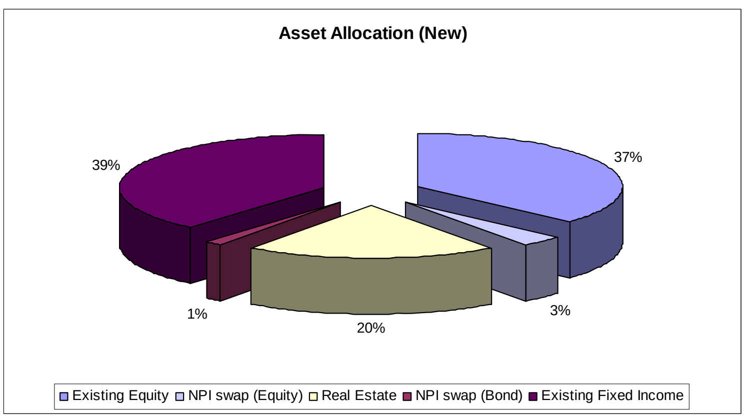
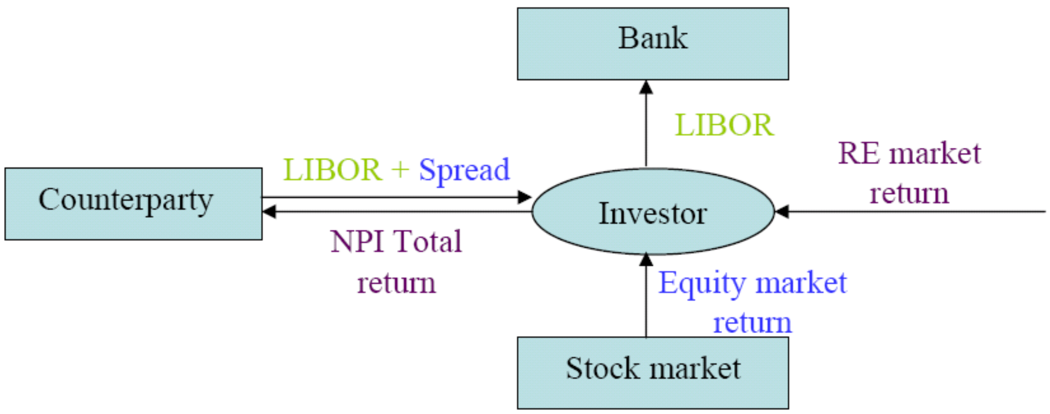


Exhibit I-9. New asset allocation

investor A easily achieves the target allocation level in the portfolio as presented in the diagram below.

Exhibit I-10. Re-allocation between asset classes through the NPI total return swap



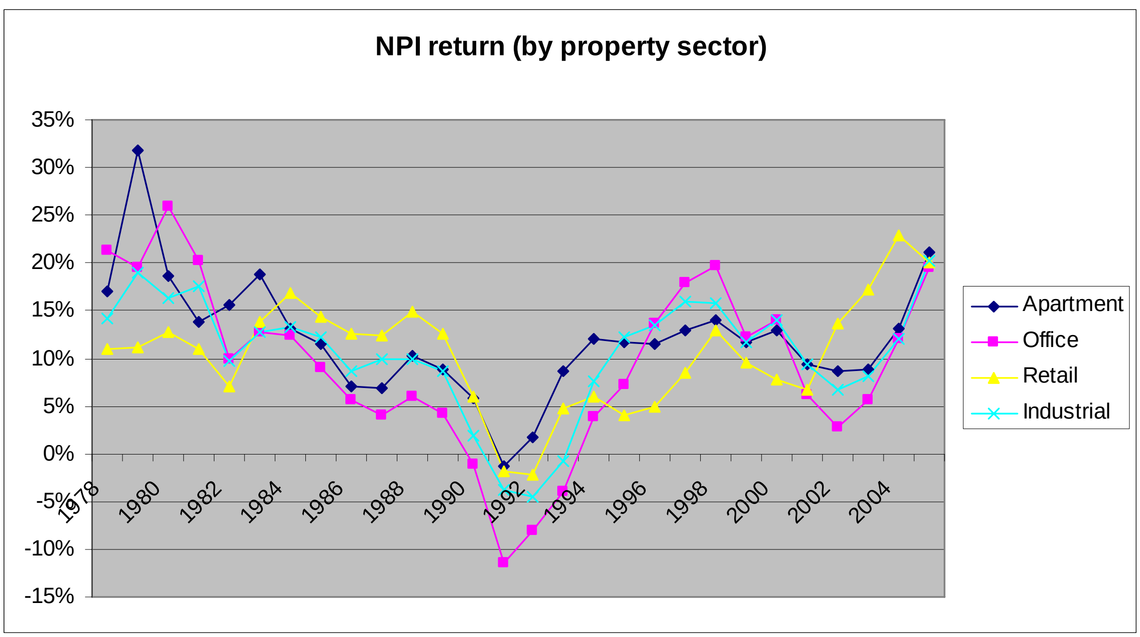
Re-balancing portfolio sectors

Consider a real estate investor who has invested primarily in office and retail sector. The investor set 70% in the office sector and 30% in the retail as the target sector balance and currently manages the $100 million worth of portfolio at the target level. This investor then considers acquiring another real estate portfolio that has 50% each in retail and office for the total value of $50 million. Although the investor finds the portfolio very attractive, it is too heavily weighted in retail from his/her perspective. In order to solve this problem, the investor enters into the NPI property type swap where s/he receives the office return and pays the retail return plus spread for $10 million notional value, and proceeds with the plan to acquire the portfolio. Consequently, the investor maintains the exposure on each property sector at the target level for the new $150 million worth of portfolio by converting the excessive retail exposure into the office exposure through the NPI property type swap as presented in the exhibit I-11 below.

Exhibit I-11. Re-balancing portfolio sectors through the NPI property type swap

In addition, since the real estate cycles between sectors are somewhat different as seen in the exhibit I-12 below, the NPI property type swap can also be used as an efficient tool for actively rebalancing the real estate portfolio according to the expectation on each property sector.

Exhibit I-12. NPI total return by property type



International Diversification

Investor B, who has large real estate holdings in the U.S., seeks to diversify the portfolio internationally. As the first target market for international diversification, the investor chooses the property market in the UK, but is concerned about the lack of knowledge and expertise in that market. Moreover, s/he soon finds that the transaction cost in the UK is higher than that in the U.S. After taking a few alternatives into consideration, investor B chooses to use real estate index swaps to reduce the exposure in the U.S. and to gain the exposure in the UK property market without incurring any significant transaction cost or taking the risk resulting from the lack of expertise in the new market. While the IPD all property index swap[11] enables the investor to receive the UK property market return, the fixed spread on the IPD index swap is offset by the fixed spread received from going short in the NPI total return swap.

Exhibit I-13. International diversification using real estate index derivatives

Although real estate index derivatives are offered only in a few countries, once the market develops in other countries, the usage of real estate derivatives for international diversification is expected to increase dramatically. Besides, for those countries where investors need to take the title risk, this strategy will provide a good alternative to get around the problem.

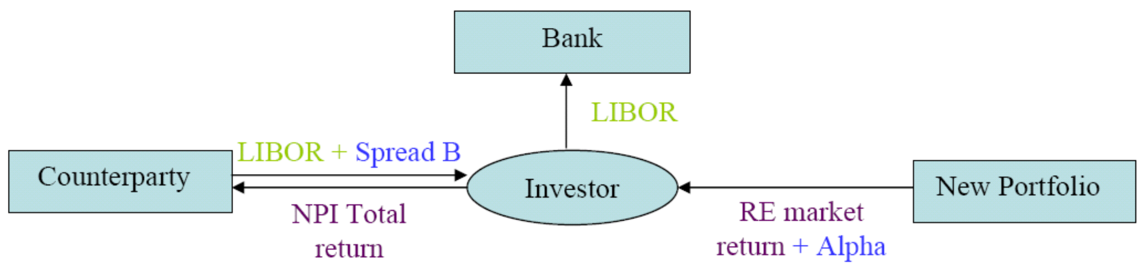
Trading Alpha

Suppose that investor C, who manages a mixed asset portfolio with a significant portion invested in real estate, has had a very good track record in managing the real estate portfolio consistently earning alpha over the average market return. However, the investor also has the internal investment guideline on the maximum exposure that a single asset class can have in the portfolio.

[11] Real estate derivatives in UK will be discussed in more detail in the next section

Then, the investor finds another real estate asset portfolio that has a good potential to generate alpha. Despite the attractiveness of this acquisition opportunity, the investor can not just purchase the portfolio as it will cause the real estate exposure to exceed its internal guideline. However, in order to take advantage of this profitable opportunity while conforming to the internal guideline, investor C can use the NPI total return swap. As illustrated in the diagram below, the investor can go neutral in terms of real estate exposure by acquiring the portfolio and going short in the NPI total return swap with the swap notional value same as the value of the new portfolio. Also, if the acquisition is funded mainly by borrowing from banks[12], the interest payments will then be offset by the LIBOR + spread received from the NPI total return swap. After all, the investor earns Alpha + Spread B from this trading strategy without any significant change in the exposure on each asset class. This trading strategy is illustrated in the exhibit I-14.

Exhibit I-14. Trading alpha using the NPI total return swap



In addition, for those who have expertise in a specific property type, the NPI property type swap can be used to take advantage of this active alpha trading strategy.

[12] Here we assume that the investor borrows at LIBOR

UK Experience in Real Estate Derivatives

While real estate derivatives are still a new concept in the U.S., they have existed in the UK for more than a decade. It was not until the last two years does it look increasingly promising with growing transaction volume (measured by notional value). In this section, we offer an overview of real estate derivatives in the UK, from its history to current market status and conclude by sharing our opinion on what makes real estate derivatives a success in the UK.

The UK real estate derivative market is currently estimated to be well over £1 billion (notional value). Most trades to date are either Property Index Certificates (PICs) [13] or total return swaps traded against LIBOR for a term between 1-3 years of the Investment Property Databank (IPD). It took the market more than ten years and failures in some cases to get to this point.

History

One of the very first real estate derivative products was futures on the IPD index launched on London Fox in 1991 that failed in the scandal of false trades designed to manipulate the market perception on trading volume. Barclays Bank launched PICs in 1994 and PIFs[14] in 1996. These products, while more of a bond than a derivative, can achieve what a pure derivative can achieve: it enabled Barclays to reduce its real estate exposure quickly and without selling the physical properties and investors to increase real estate exposure quickly without owning the physical

[13] PICs: Property Index Certificates, Eurobonds issued by Barclay Capital resulting Barclay Capital receiving the total return on IPD in return for the payment of a fixed rate of interest to an investor. Strictly speaking, it's not the "contract of difference" type of derivatives we've been discussing in this thesis since capital is exchanged upfront.
[14] PIFs: Property Index Forwards, similar to PICs, but based on capital return only

properties. PICs and PIFs have proven to be relatively successful with £800 million and £400 million origination respectively.

Exhibit I-15. IPD swap trading volume

	Deals completed
Q4 2004	£200m
Q1 2005	£320m
Q2 2005	£500m
Q3 2005	£700m
Q4 2005	£850m?
Q1 2006	> £1bn??

The first pure real estate swap transaction was £40 swaps arranged by Deutsche Bank and Eurohypo in January 2005. Since then the market has been growing very fast. At a recent IPD hosted conference, it was claimed that property derivatives could make up to 14% of the £300 billion of real estate allocation held by funds in the UK market. Accounting firm, Deloitte, also estimates that the market could be worth £10 billion to £20 billion over the next three years.

Market Participants

Currently, eleven major investment banks are licensed to use the IPD UK indices to develop and sell real estate derivatives. The investment banks have been shy away from taking positions in transactions although some banks have expressed willingness to warehouse risk in which case the bank will take the opposite position while they try to locate counterparty. The investment banks may source the deals directly themselves or via brokers, and they seek to make money on the spread between the prices agreed to by the two opposite parties.

Derivative brokers are also actively involved in the market. Top financial brokers often team up with a property broker to work together to match the trades and sell the IPD derivatives. For example, GFI has teamed with CBRE; Tullett-Prebon has teamed with DTZ. The brokers will take a small commission as a one-time fee up front, normally less than 10 bps. Some of the largest institutional investors in the UK like Prudential and Hermes, along with IPD and IPF (Investment Property Forum) have also been very keen in seeing real estate derivative develop and therefore are playing major roles in educating investors via various training events and conferences.

Pricing

Some indicated pricing on the UK IPD derivatives are shown in the exhibit I-16. The "Consensus Pricing" is calculated from prices provided by the participating banks to IPD.

Exhibit I-16. Consensus pricing on IPD swaps

Total Return Swap Consensus Pricing
Term: 2 3/4 Year to Dec 31st, 2008

	Spread over LIBOR (bps)	Spread over All Property Index (bps)
All Property	310	-
City Offices	530	220
West End Offices	530	220
Rest UK Offices	380	70
Industrial	290	-20
Retail Warehouses	340	30
Shopping Centers	160	-150
Unit Shops	140	-170

* Source: Hermes Property Derivatives Trading Forum

Lessons from UK

While the UK is making significant progress in developing an active and liquid real estate derivative market, we only see limited interest in the NPI derivatives in the U.S. So far, only two trades with total notional value of $30 million have been reported. It would be natural to ask what make this huge difference between two markets, given all the benefits that real estate derivatives can provide. Several things unique about UK real estate market make real estate derivative seemingly more attractive and feasible than they are in U.S.

First, real estate investors in the UK seem to be more comfortable with the IPD index in terms of its ability to track the underlying market than their counterparties in the U.S. are with the NPI, although both indices are appraisal based. Moreover, appraisal has traditionally been well respected as a profession in the UK and people are more ready to accept appraised value as market value. As a result, rather than being driven by the market in the case of the NPI in the U.S., the IPD index even drives the market to certain extend. Second, real estate transaction cost tends to be higher in the UK than in the U.S., which makes real estate derivative a more attractive alternative in the UK. The round trip transaction cost runs about 6-8% in the UK versus 4-6% in the U.S. Legislative changes announced at the end of 2003 have also increased the interest from life insurance companies in real estate derivatives which now can be included in solvency ration calculation. In addition, capital losses from real estate derivative trading could be offset against tax.

There are two other reasons very critical to the success of real estate derivatives in the UK, which may also explain why the U.S. is falling behind. First, investment banks are playing a very important role in the UK. Eleven banks as a whole can greatly enhance and expedite the "price discovery" process as investors shop for pricing, which in turn can increase the liquidity. Eleven banks can also have large client coverage in terms of marketing and education. Real estate derivatives could be intimidating if investors do not understand it. Second, there has been clearly a strong leadership in the UK in pushing the development of real estate derivatives (Barclays, Hermes, Prudential, and etc.) that is clearly lacking in U.S. Investors need to see the real benefit of these derivative products before they actually decide to trade the new product, but the very benefits investors are eager to see can only be achieved from investors actively participating in the derivative market. This vicious circle can only be broken by strong leadership and initiatives from reputable investors who have yet to emerge in the U.S. To make real estate derivative also a success in the U.S. will take more than one educator, market maker, product developer, broker and leader.

Chapter Two: Investors Survey on real estate derivatives

In this chapter, we are summarizing the results from the investors survey we conducted in conjunction with Credit Suisse to identify the investors interest level and concerns among U.S. investors in real estate derivatives. In the second half of the chapter, we analyze the results of a similar survey conducted by Hermes Real Estate at the property derivatives trading forum in the UK. Both surveys help us understand the market potential of real estate derivative. A comparison of the results from the two surveys tells us some very interesting information and insights on where both countries stand in the development of a real estate derivative market.

Investors Survey – U.S.

The investors survey is a web-based survey carried out between June 14th and July 14th. The identity of the respondents remains anonymous and does not appear on the survey result. Credit Suisse helped us in identifying the potential investor group who would be interested in real estate derivatives and voluntarily participate in the survey to enhance the breadth and relevance of the participants. The group was consisted of various kinds of investor community including investment managers, fund managers, commercial lenders, and brokers. At the conclusion of the survey, a total of 37 participants completed the survey out of 86 visits to the survey website.

Among those who participated in the survey, 43% identified themselves as investment manager. Commercial lenders and brokers formed the second largest group, each representing 14% of the total respondents. We categorized the participants into three groups, investment managers, other investors, and non-investor group so that we can compare the responses of different groups. While ‘other investors’ group is composed of commercial lenders, banks, and other fund managers, the non-investor group is those who would have interest in real estate derivatives but would not be able to make an actual investment in derivatives, including brokers, real estate research firms, and consulting firms.

Although most participants were already aware of real estate derivatives prior to this survey, we also provided basic information about the NCREIF property index and real estate derivatives currently offered by Credit Suisse to deepen the participant’s understanding of the product.

The result of the survey reveals many interesting findings about the investors’ needs and concerns on real estate derivatives as well as the potential of real estate derivatives market. Here we present a few key ones among them, and the full result of the survey will be found in the appendix of this paper.

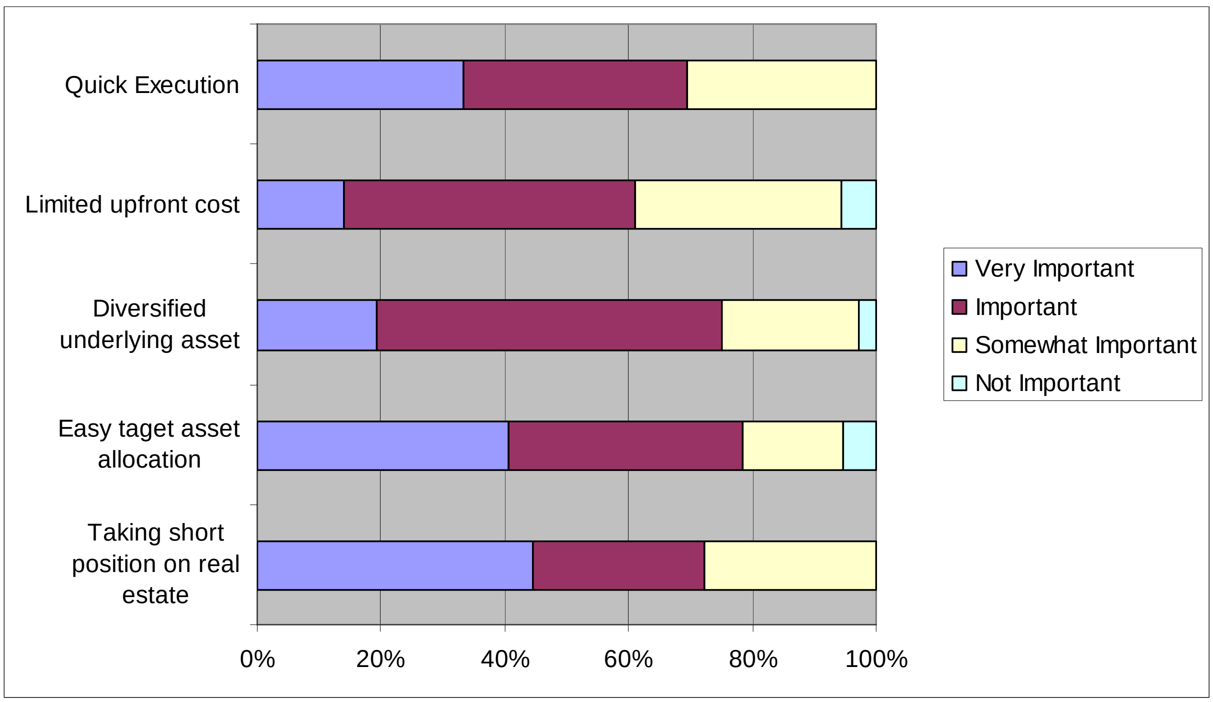
Benefits of real estate derivatives

The survey shows that most investors regard taking short position on real estate and easily achieving target asset allocation as the main benefits of using real estate derivatives relative to direct property investment or REITs. As the exhibit 2-1 shows, more than 40% of respondents find those two benefits very important while the benefit of limited upfront cost is considered relatively less important. Investors also pointed out other benefits of real estate derivatives as follows,

- Creation of synthetic exposure to asset class with low capital commitment

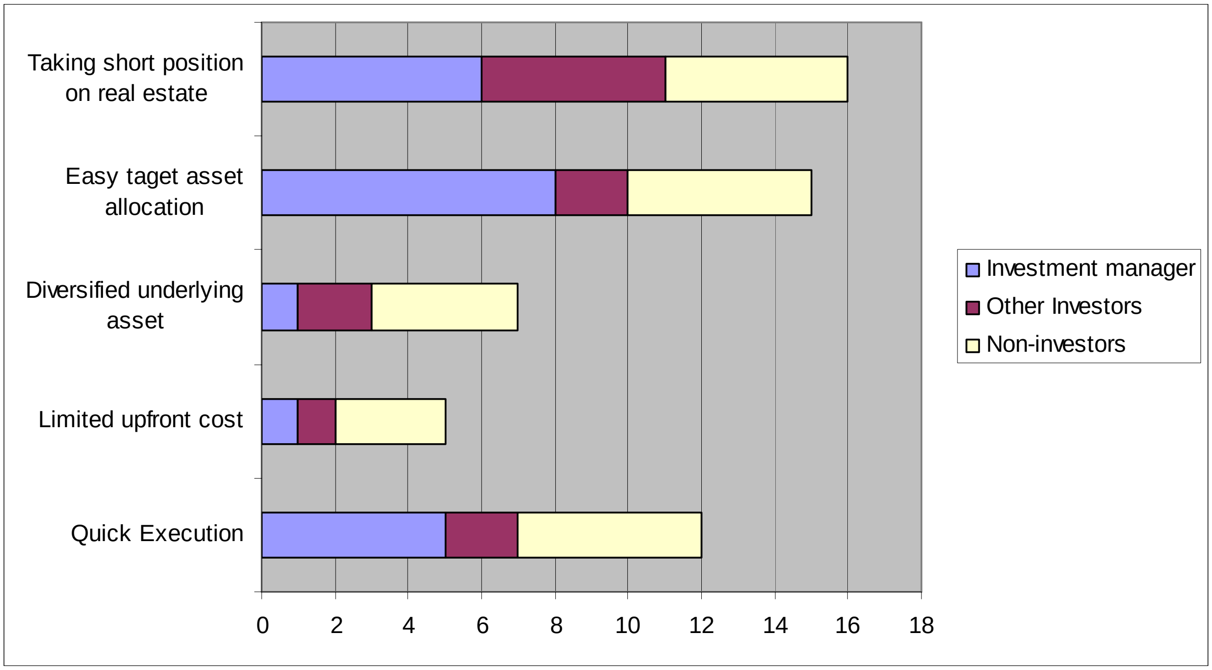
- Ability to achieve NCREIF return
- Increased and specialized alpha strategies while hedging the overexposure in real estate by using real estate derivatives
- Development of risk management applications which will bring private real estate more in line with other asset classes.

Exhibit II-1. Benefits of real estate derivatives



Taking a closer look at those who choose “very important” to each benefit reveals another interesting result. As we can see in the exhibit 2-2, investment managers are more interested in easy target asset allocation while other investors including commercial lenders find taking short position on real estate more beneficial to them.

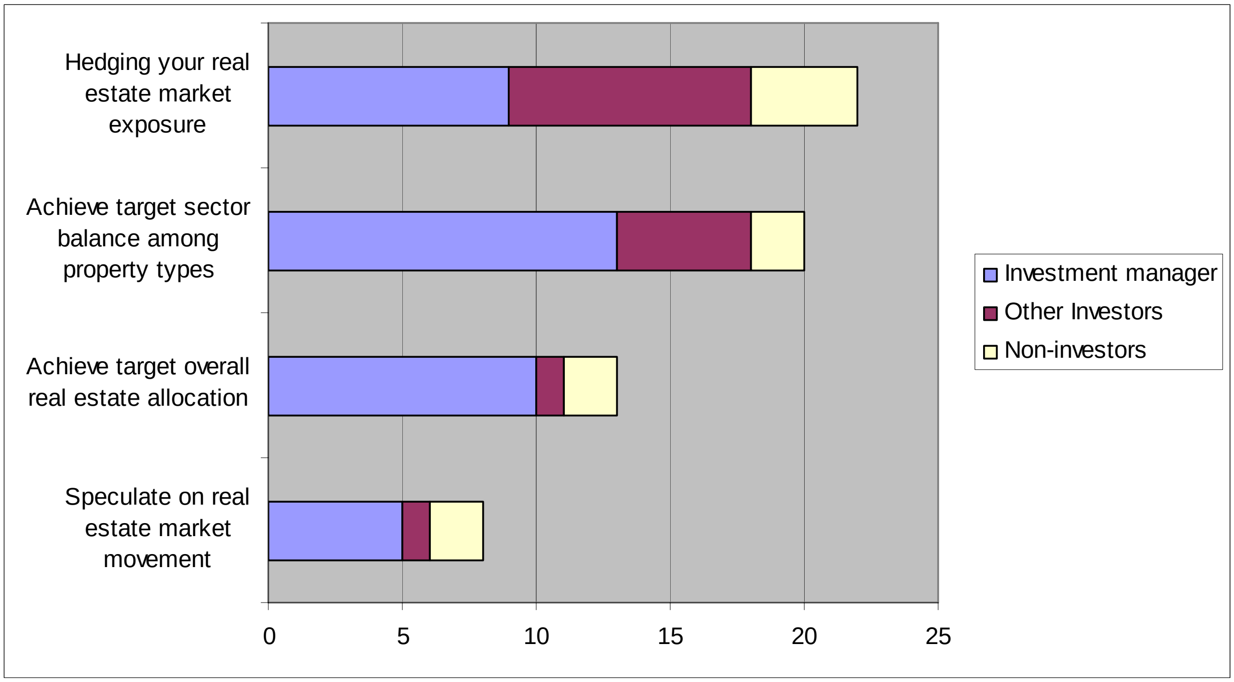
Exhibit II-2. Benefits of real estate derivatives (by investor type)



It is not surprising that these findings on the benefits of real estate derivatives are also closely related to the investors' main purpose of using real estate derivatives. When investors were asked about their main purpose for using real estate derivatives, two thirds of the respondents selected hedging real estate market exposure, which were then followed by achieving target sector balance among property types.

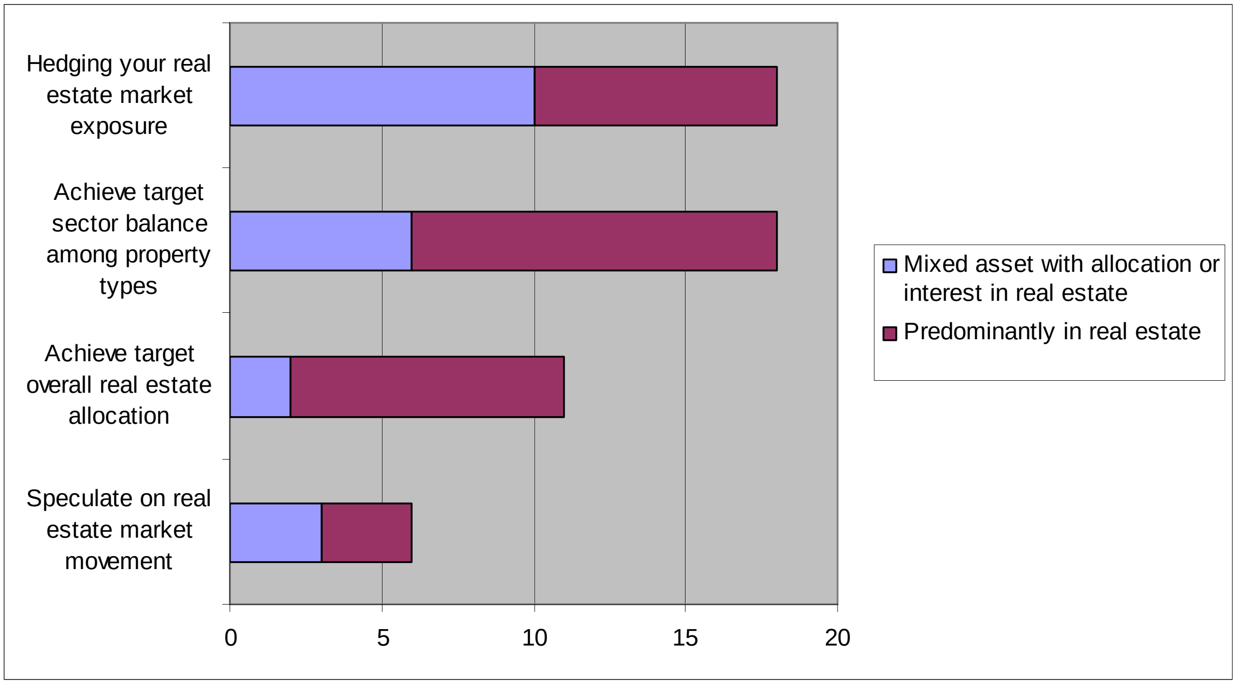
Moreover, the exhibit II-3 shows that investment managers, who were interested more in easy target asset allocation than taking short position on real estate, answered that they would use real estate derivatives mainly for achieving target sector balance among property types.

Exhibit II-3. Main purpose of using real estate derivatives (by investor type)



In order to analyze this further, we excluded non-investors from the sample and regrouped investors by their asset allocation type. This analysis let us find that those managing a mixed asset portfolio with allocation or interest in real estate expected that they would use real estate derivatives more for hedging purpose than for asset allocation purpose while those with assets predominantly in real estate showing greater interest in achieving target sector balance among property types. This result is illustrated in the exhibit II-4.

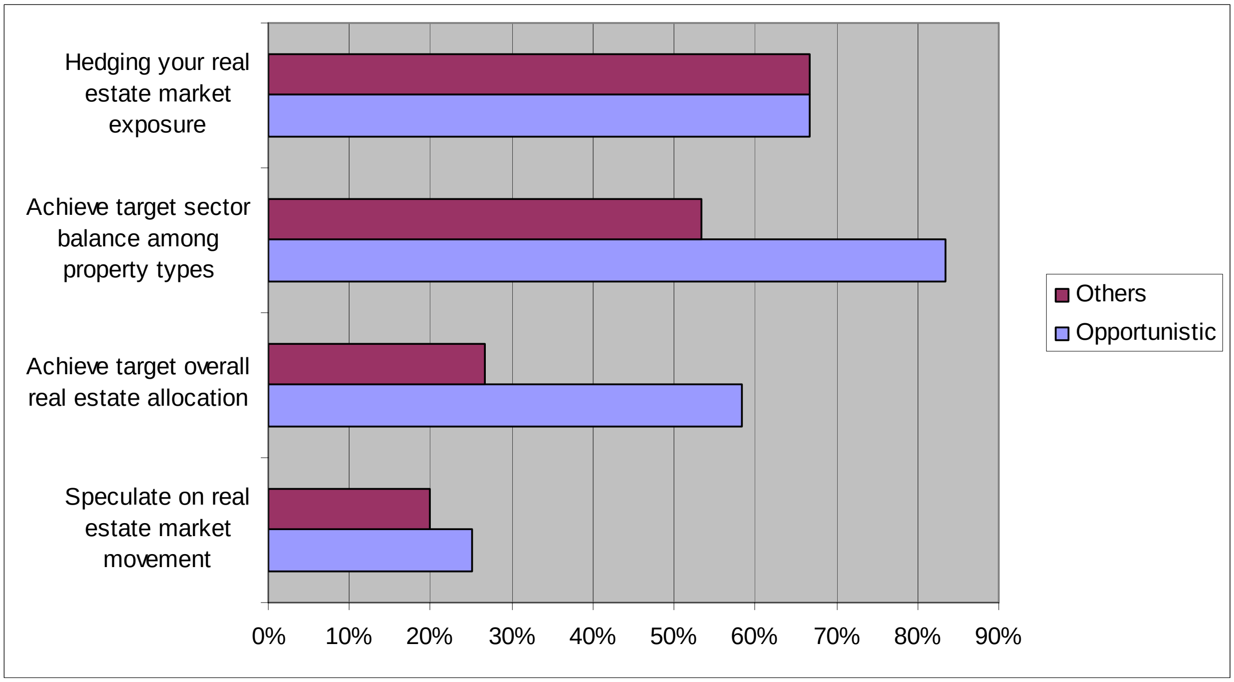
Exhibit II-4. Main purpose of using real estate derivatives (by asset allocation type)



In addition, similar analysis based on different investment styles indicates that investors with opportunistic investment style find real estate derivatives more useful as a tool to achieve target sector balance among property type or target overall real estate allocation compared to those with core or value-added investment style do[15]. The opportunistic investors were particularly interested in achieving target sector balance among property type with more than 80% of them choosing it as the main purpose of using real estate derivatives as shown in the exhibit II-5. This suggests that investors with opportunistic investment style be one of the major users of property type swap which allows an easy change in property sector allocation in their portfolio.

[15] The following description was used to define the investment styles
Core: stabilized properties, low or no debt, relatively passive management
Value-added: more debt, turnaround, higher risk & return compared to core
Opportunistic: more debt, development, broader vehicles, and active management

Exhibit II-5. Main purpose of using real estate derivatives (by investment style)

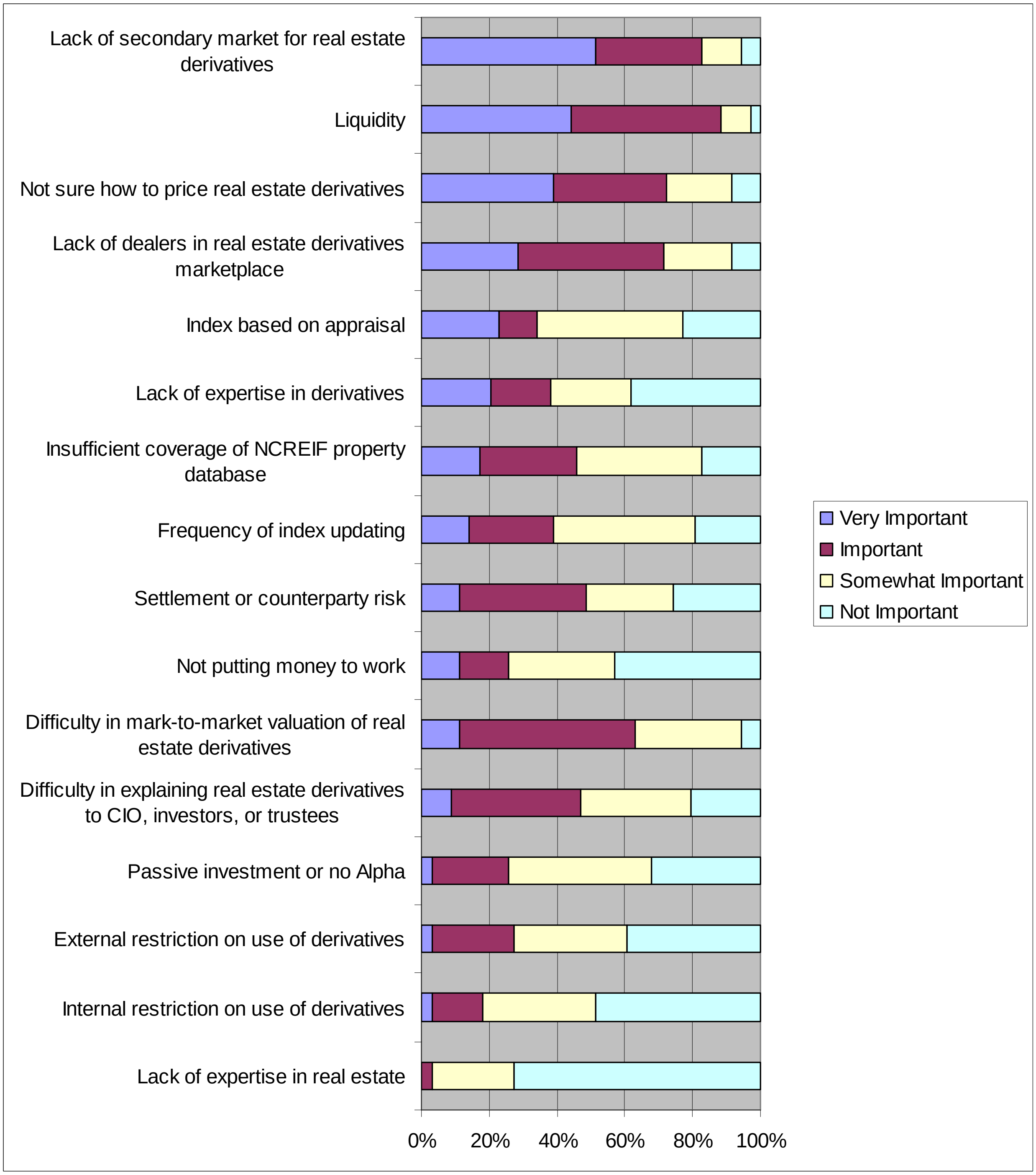


We can conclude from these findings that investors clearly have different views on the value and effectiveness of real estate derivatives depending on their type, asset allocation, or investment style, and that these heterogeneous views will guarantee the development of various kinds of real estate derivatives.

Concerns in real estate derivatives

Despite the benefits that have been addressed so far, there are numerous concerns that prevent investors from actually investing in real estate derivatives. Among those issues that have been discussed among investors, we tried to figure out the major ones that investors perceive, by asking participants to rate the importance of the issues. The detailed result of this survey is presented below in the exhibit II-6.

Exhibit II-6. Major concerns in real estate derivatives



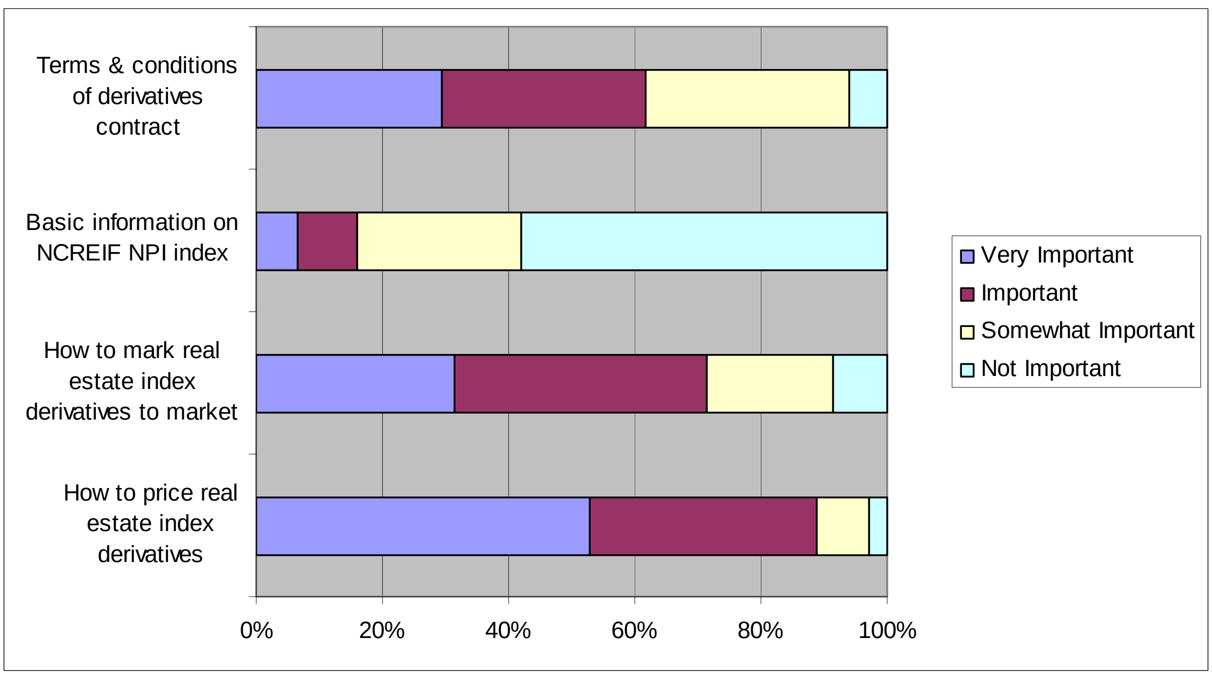
From this result, it is apparent that the biggest concern that investors have in real estate derivatives is related to the liquidity issue. More than 80% of the participants in the survey found liquidity issue and lack of secondary market for real estate derivatives very important or important. Given that real estate derivatives are completely new products, it is a natural outcome that investors consider liquidity related issues their primary concern. Furthermore, from risk management perspective, lack of secondary market, another aspect of liquidity problem, is definitely a huge problem as the cost of unwinding existing derivative positions can be very costly without an active secondary market. While the liquidity issue discourages investors from actively participating in real estate derivatives market, it is also difficult to solve this problem without their active participation, which basically creates a vicious spiral slowing down the development of the market. Therefore, more efforts should be made in order to mitigate other concerns investors would have in investing in real estate derivatives and make the new product more attractive to them so that investors can willingly participate in the process of enhancing the liquidity of the market.

Among the issues related to the index, respondents considered the problems associated with the nature of appraisal based index most important. Since the NPI is appraisal based rather than transaction based, the NPI return has inertia in it and tends to lag the performance of underlying real estate market. This lagging nature of appraisal based index can be a significant problem especially when investors use the real estate derivatives in relation to the exposure in underlying real estate market such as hedging. We will discuss this issue further in the later part of our study.

Another important issue that needs to be addressed is that potential investors still find it difficult to understand the concept of real estate derivatives. Among the major concerns highly rated by participants are those related to this issue, including the concerns on pricing, mark-to-market, lack of expertise in derivatives, and lack of dealers in real estate derivatives marketplace. We believe that this issue can be more easily resolved by providing a training course on real estate derivatives and educating real estate investors who have not had the chance to invest in derivatives.

This finding is also confirmed in another question in the survey where we asked which area they would be most interested in if a training course on NCREIF property derivatives is provided. Most respondents answered that a training course on the pricing and mark-to-market method of real estate derivatives would be important while showing little interest in the NCREIF Property Index which the derivatives are written on.

Exhibit II-7. Topics to cover at a training course on real estate derivatives

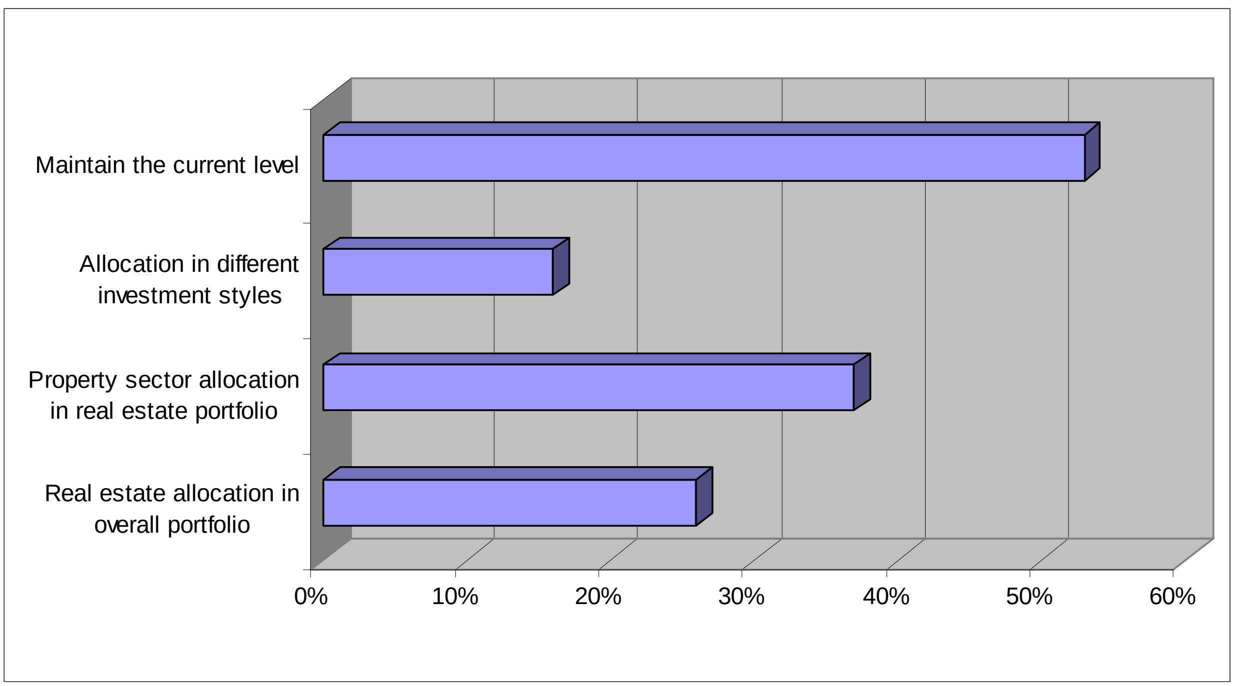


Other suggestions on training course include trading strategies using real estate derivatives and presentation of actual transactions as well as other real estate derivatives such as the IPD index derivatives in U.K.

Potential market for real estate derivatives

Although we have focused mainly on understanding the general needs and concerns investors have in real estate derivatives so far, we also tried to identify potential markets for real estate derivatives in our survey. As the first step, we asked participants a few questions to enable us to classify them by their characteristics, including whether their organization intends to change its current real estate allocation level. As we have already seen in the preceding analysis, real estate derivatives are regarded as an effective tool to achieve target asset allocation level not only in terms of overall real estate exposure but also in terms of property sector allocation. And thus, we supposed that higher needs for investors to change the current real estate allocation level would ensure higher demands for real estate derivatives.

Exhibit II-8. Needs to change the current real estate allocation level



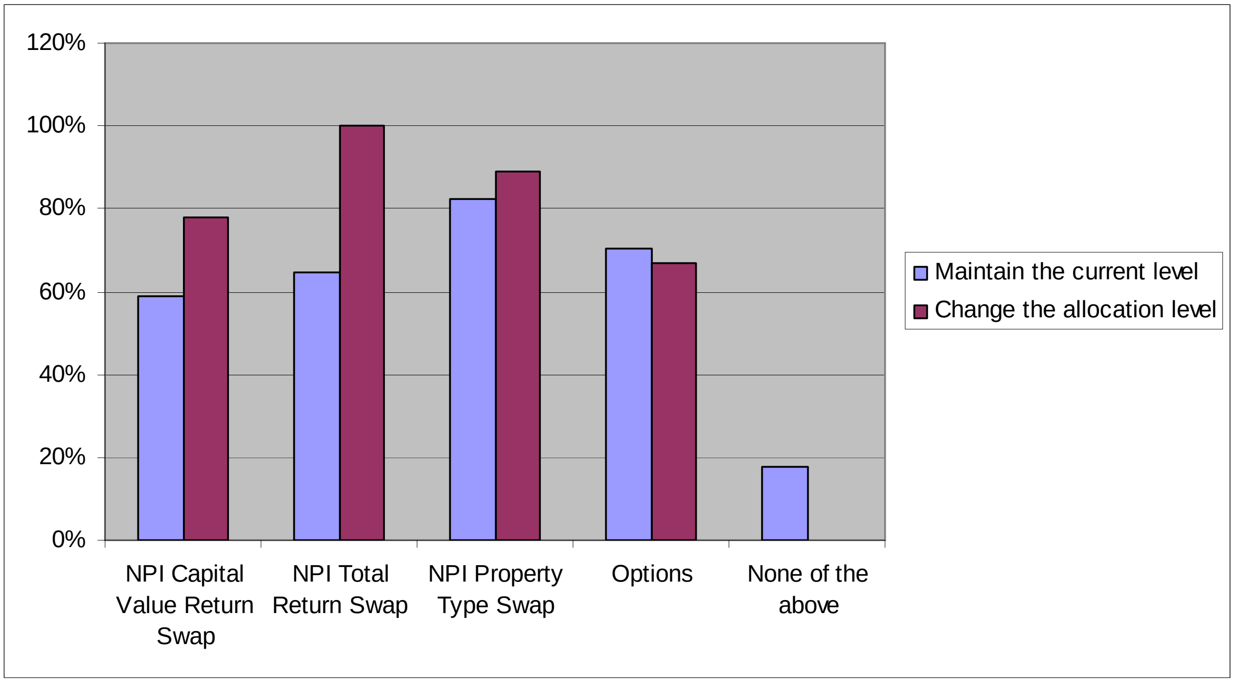
According to the survey, investors currently have surprisingly great needs to change their current real estate allocation level. As seen in the exhibit II-8, nearly half of the respondents[16] said that their organization would need to change its current real estate allocation level. Furthermore, many of them had multiple needs with the one to change property sector allocation the highest among them.

We can expect that each real estate derivative currently offered can be very effectively used to fulfill these needs. For those who intend to change real estate allocation in overall portfolio, capital value return swap or total return swap will provide an easy and quick solution. Property type swap will help the investors who plan to change property sector allocation in their real estate portfolios. Also, those who want to change allocation in different investment styles can use real estate derivatives as a way to manage their risk exposure to real estate with low capital commitment.

These expectations on the demand for real estate derivatives are also verified by the following analysis. When asked to choose the type of real estate derivatives they would be interested in, those who previously answered that they had the needs to change the current allocation level showed more interest in real estate derivatives regardless of the type, compared to those who would maintain the current asset allocation level. Moreover, among all the investors who participated in the survey, almost 90% said that they would be interested in at least one type of real estate derivatives.

[16] For the purpose of this analysis, non-investors were excluded from the sample.

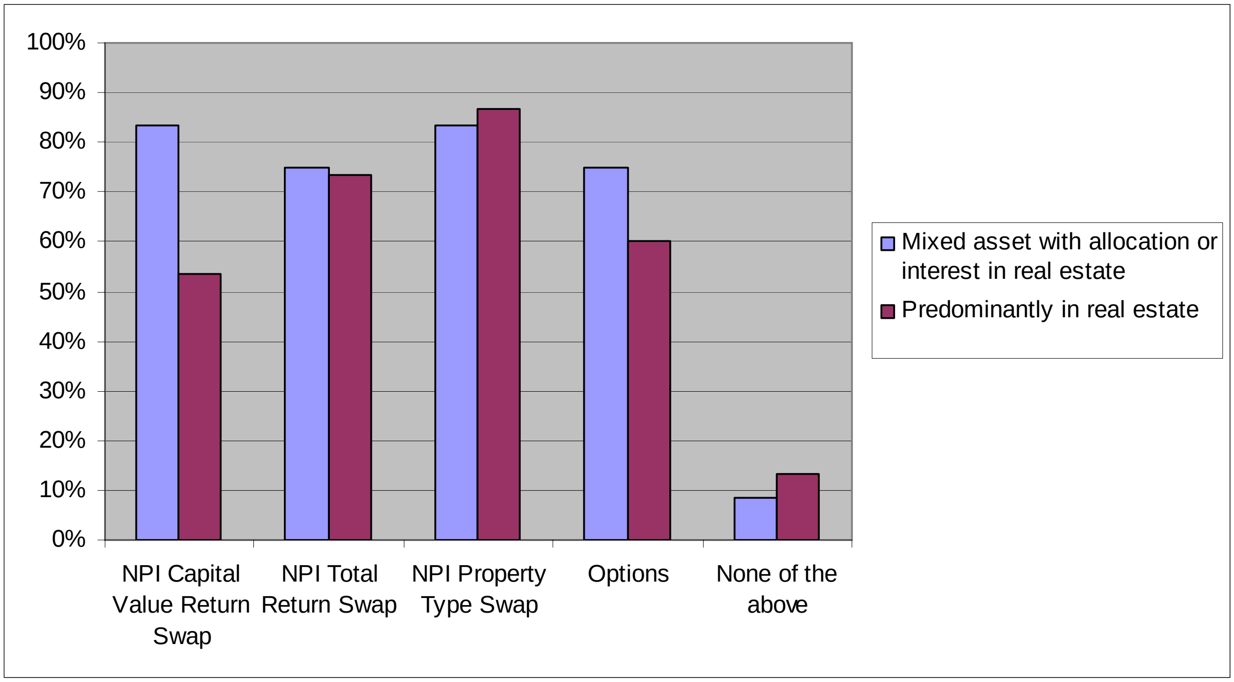
Exhibit II-9. Real estate derivatives investors are interested in (by needs to change the allocation level)



A slight different analysis on the same question shows another interesting point, which is illustrated in the exhibit II-10. While those who manage a mixed asset portfolio with allocation or interest in real estate show relatively high interest in most real estate derivatives types, the investors who manage assets predominantly in real estate demonstrated noticeably high interest in property type swap. This result is in line with our previous finding that those type of investors regard real estate derivatives as a particularly effective tool to achieve target sector balance among property types.

It is also interesting to find that investors were generally more interested in total return swap than capital value return swap. While capital value return swap is expected to be more preferred by those who intend to hedge their exposure or go short in real estate, total return swap is more effective for those who synthetically increase the exposure to real estate. Therefore, we can infer from the finding that there is significant demand for using real estate derivatives to go long in real estate rather than directly investing in properties.

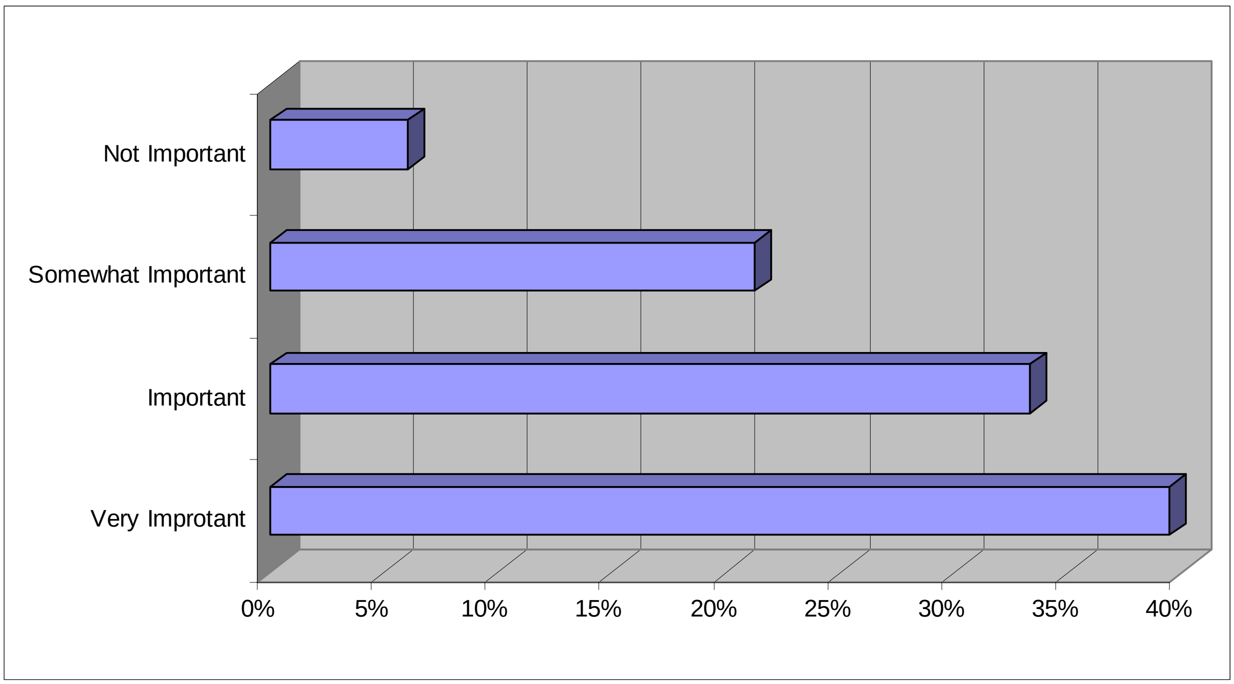
Exhibit II-10. Real estate derivatives that investors are interested in (by asset allocation)



In addition, the result reveals that there might be significant demand for other type of real estate derivatives. Two thirds of respondents showed interest in options written on real estate index, which indicates that the next step to be taken to expand the market is to develop new products. Even in real estate swap market, most participants in the survey considered developing real estate derivatives based on geographic regional indices either very important or important as shown in the exhibit II-11.

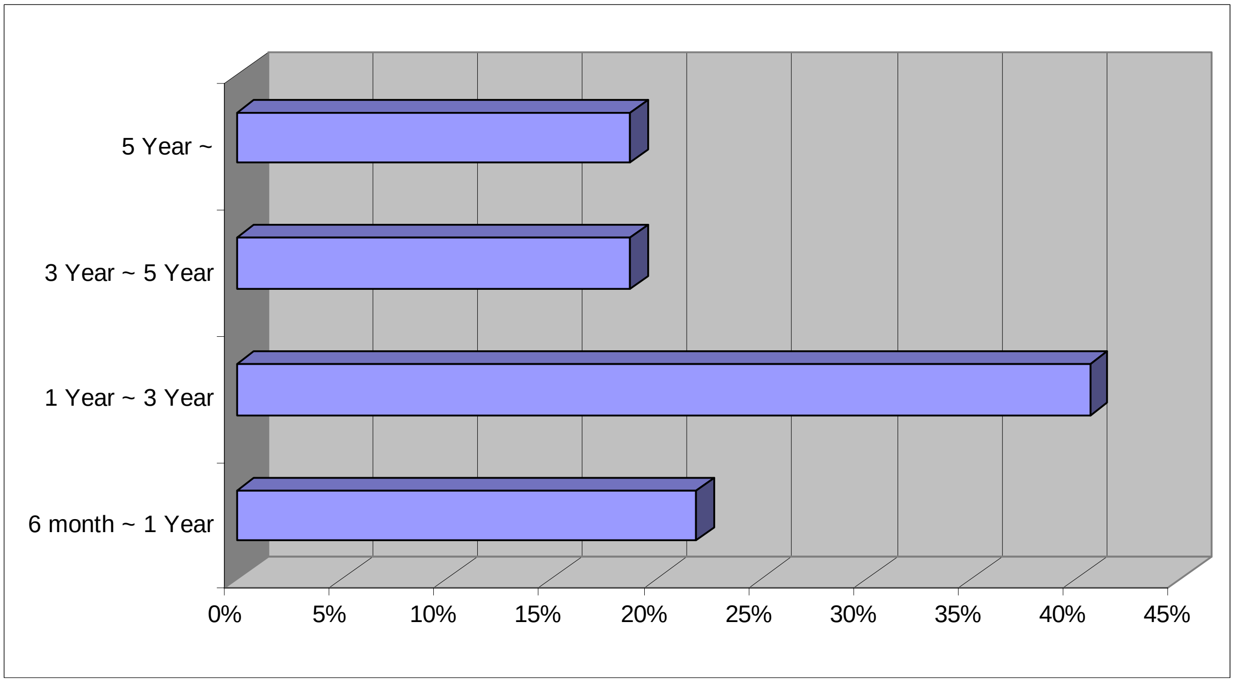
Since the NPI swaps currently offered are based on the all-US NPI return, those who have real estate exposure only in a specific region may face significant basis risk in using the swaps in relation to their existing portfolio. Developing real estate derivatives based on geographic regional indices, such as property type swap that exchanges the return on office in eastern region with that on retail in western region, would help mitigating this basis risk. Given that the major concern on real estate derivatives is related to the liquidity issue, however, more specific derivatives contract may be found more difficult to achieve enough depth in the market.

Exhibit II-11. The importance of real estate derivatives based on geographic regional indices



With regards to the maturity, 1 to 3 year contract horizon is selected as the most useful term for real estate derivatives. In order to provide the secondary market to existing contracts, however, the market for those with shorter maturity should be developed together. In addition, once the market fully takes off and enough liquidity is provided in the market, the demand for derivatives with a longer maturity is expected to increase since there is also a demand to match the duration with typical investment period of underlying property market.

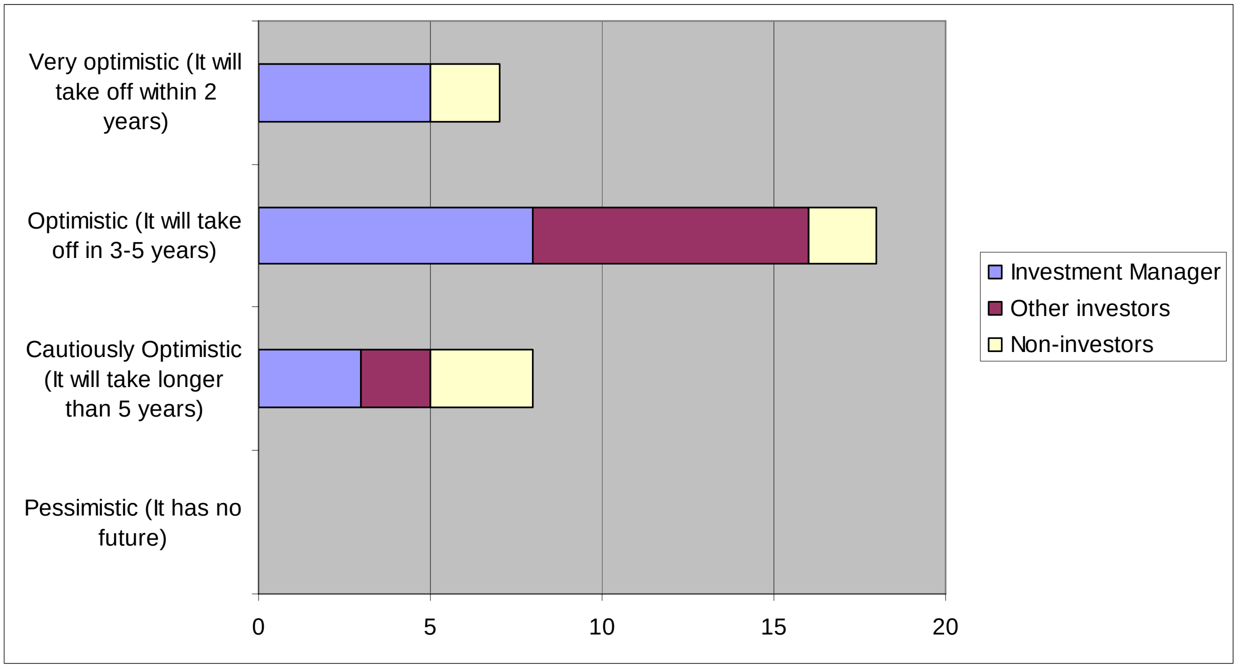
Exhibit II-12. Most useful maturity of real estate derivatives



Prospect of real estate derivatives

As a closing question of our survey, we asked participants how they feel about the prospect of real estate derivatives in the U.S. While more than half of respondents were optimistic about the market with the expectation that the market would take off in 3-5 years, a further analysis shows that investment managers are relatively more optimistic than non-investors about this new product. Furthermore, it is encouraging to the proponents of real estate derivatives that no respondent was pessimistic about this market. The following exhibit illustrates how different type of investors finds the prospect of real estate derivatives in the U.S.

Exhibit II-13. The prospect of real estate derivatives in the U.S.

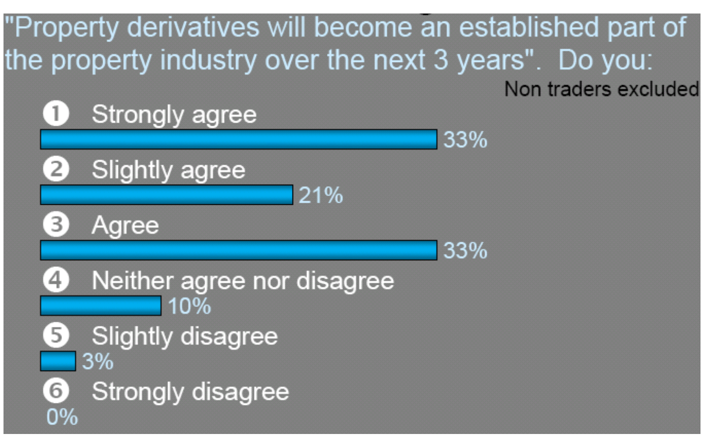


Investors Survey – UK

As already discussed in the earlier chapter, the UK real estate derivatives market has recently taken off mainly propelled by those who understood the potential of real estate derivatives and took the initiatives to develop the market for this new product. Here we will try to find what has made the difference between the UK and the U.S. by analyzing the results of the survey on property derivatives done in the UK earlier this year. The survey was conducted by Hermes Real Estate at the property derivatives trading forum, which was designed to raise derivatives awareness among investors and grow their confidence in the ability to trade. The participants included institutions, investment managers, property companies, and investment banks. The result of this survey indicates that UK investors tend to have far more favorable attitudes to real estate derivatives compared to their counterparties in the U.S. although it has been only a year or so since the market really took off in the UK.

First of all, UK investors are generally far more optimistic about the prospect of the real estate derivatives market than U.S. investors. As shown in the exhibit II-14, 87% of the UK investors who participated in the survey answered positively to the question asking whether they agreed that property derivatives would become an established part of the property industry over the next 3 years. Recall

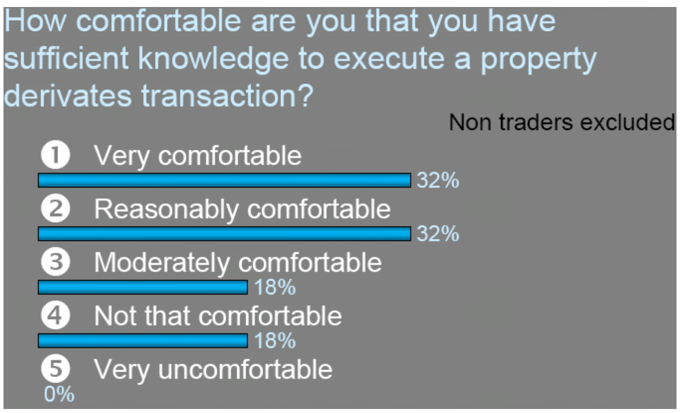
Exhibit II-14.



*Source: Hermes Property Derivatives Trading Forum that almost 80% of the respondents in our survey expect that it will take longer than three years for the real estate derivatives market to take off in the U.S. It is not just the matter of time but also the matter of confidence that makes this huge difference between two groups of investors.

The high confidence level among UK investors in real estate derivatives is partly attributable to the fact that they have sufficient knowledge to trade real estate derivatives. As we can find from the exhibit II-15, investors in the UK feel very comfortable with the level of knowledge they have in trading real estate derivatives. We already learned that majority of US investors who participated in our survey still find it difficult to understand the concept of real estate derivatives. We believe that the initiatives taken by the market leaders in the UK have made a significant contribution to raising the level of knowledge in derivatives among real estate investors there and led to higher involvement from investors in developing the market.

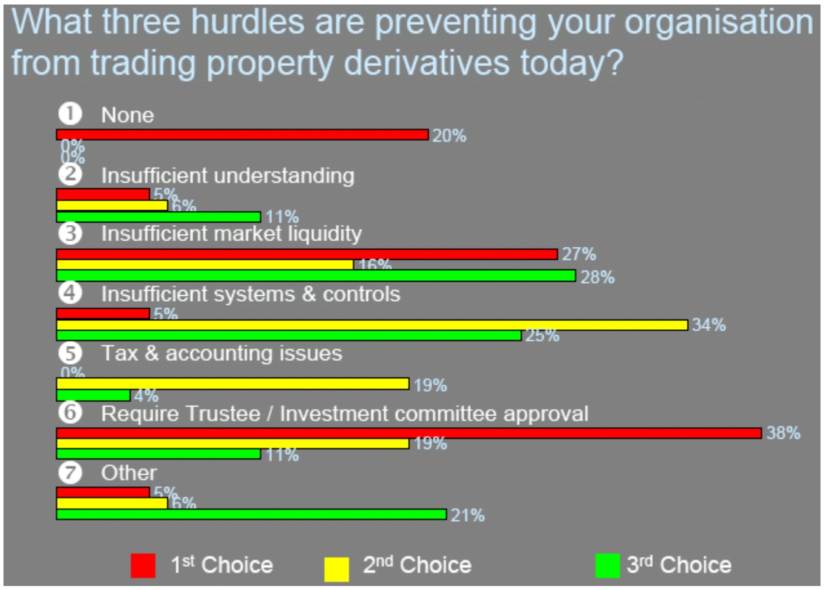
Exhibit II-15.



*Source: Hermes Property Derivatives Trading Forum

As a result, the concerns that UK investors have on real estate derivatives are somewhat different from those of U.S. investors. The exhibit II-16 presented below shows three issues that UK investors selected as hurdles to prevent them from trading real estate derivatives. Although the market liquidity issue, which was the biggest concern among U.S. investors, was also highly rated by UK investors, their major concerns are related to more practical issues such as insufficient systems & controls and trustee/investment committee approval. We can infer from this finding that UK investors already have strong willingness to trade and have reached the stage where they try to solve the final practical issues before actually starting real estate derivatives transactions.

Exhibit II-16.



*Source: Hermes Property Derivatives Trading Forum

Exhibit II-17.

*Source: Hermes Property Derivatives Trading Forum

Such an interpretation is also confirmed by the fact that more than 90% of the participants in the trading forum expected their organizations to be ready to trade real estate derivatives within next 12 months. Even with the consideration that those who participated in the trading forum must have already had significant interest in real estate derivatives, it is still a surprising outcome as those participants were composed of major investors in the UK real estate market. Furthermore, it also suggests that U.S. investors quickly make necessary steps to make themselves ready to take advantage of this new product in order to lead the market.

Finally, in terms of the type of trades they are interested in, UK investors showed a similar result to what we have found from U.S. investors. Both all property and sub-sectors swaps turned out to be almost equally of their interest. We believe that this finding indicates that investors in both countries have similar needs in using real estate derivatives. Therefore, we can expect that the real estate derivatives market in the U.S. soon will draw more attention from investor communities following its forerunner in the UK.

Exhibit II-18.

*Source: Hermes Property Derivatives Trading Forum

However, it should be also noted that significant efforts should be made by multiple market players who will lead the market with confidence in order to make any meaningful development take place in the real estate derivatives market in the U.S.

Chapter Three: Forecasting of the NCREIF Property Index

Our study so far has focused on the background information about real estate derivatives in terms of how it works, its benefits and applications, and its current market status in the U.S. as well as in the UK. We are now turning to issues related to practical use of real estate derivatives: where the NPI would go in the next two or three years and how to price real estate derivatives. In this chapter, we are addressing the first question by introducing three forecasting models on the NPI. The first two models are purely statistical product of historical data. Given the significant inertia in the NPI, it is not difficult to conceive the NPI historical returns as good predictor of the NPI future returns. The third model allows investors to transfer their expectations on the underlying property market into the NPI returns as a way to overcome the lagging nature of the NPI, an issue we will discuss next.

The NCREIF Property Index (NPI)

Since the real estate derivatives currently available in U.S. is written on the NPI, it would be very helpful and important to have an idea on where the NPI goes in the future in order to price the derivatives. Before we introduce three predicting models and their predictions, a brief discussion on the NPI is warranted.

The NPI is a value weighted time series composite total rate of return measure of investment performance of institutionally-owned commercial real estate properties acquired in the private market by Data Contributing Members (DCM)[17]. The NPI is thus intended to reflect the performance of private real estate as opposed to public real estate (REITs). As of the 2005 4th quarter, the NPI includes over 4,700 properties with an estimated market value exceeding $189 billion, which makes the NPI a big enough sample to represent the entire universe of institutionally-owned commercial real estate in the U.S. private market.

The NPI total returns are reported quarterly on unlevered basis, broken out by capital value returns (appreciation) and income returns[18]. Property type sub-indices (apartment, office, retail and industrial) as well as geographical sub-indices (East, West, Midwest and South) are also reported quarterly. These sub-indices make it possible for real estate derivatives to be used to adjust property type and/or geographical exposures.

The NPI is an appraisal based index since the capital value component of return is predominately the product of property appraisals done each quarter either internally or externally. The appraisal practice considers recent sales of comparable properties, replacement cost, and other appraisals of similar type of assets and is thus inherently backward looking. As a result, the NPI presents great amount of inertia making it relatively predictable for the next one or two quarters.

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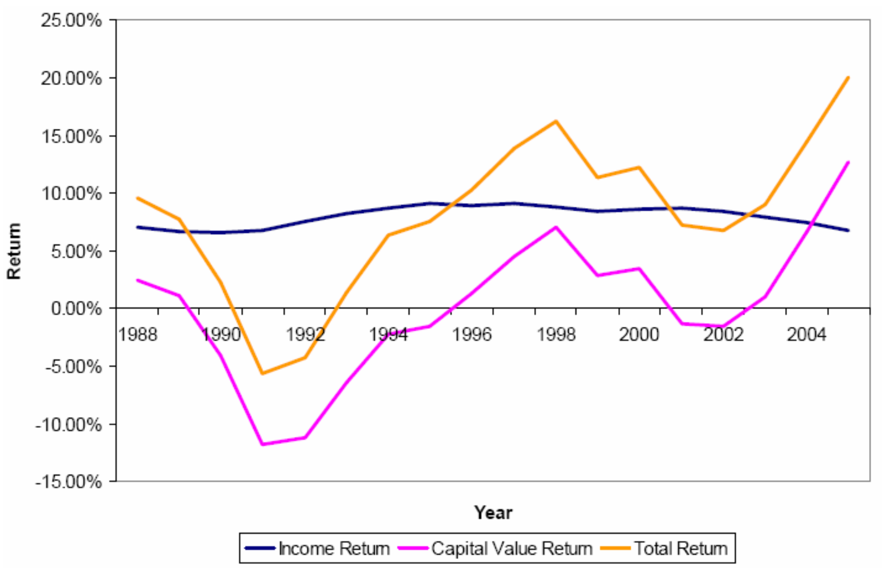
[17] Data Contributing Members include real estate investment managers/advisors, tax-exempt institutional real estate investors and other institutional investors such as insurance companies and public real estate investment trust.

[18] Income Return – return attributable to each property's net operating income (NOI) or cash flow (NOI-capex). Capital Value Return – the percentage change in market value for the applicable quarter net of any capital expenditures if income return is based on NOI or gross of capital expenditures if income return is cash flow based. Capital Value Return may also be referred to as the Appreciation Return or the Capital Appreciation Return.

Forecasting Models

Our first two forecasting models using autoregression are designed to predict the NPI capital return component, the major source of the index's variability since the income return has been relatively stable over the years[19]. Furthermore, the models are based on yearly return data rather than quarterly return data as there is too much noise in quarterly data, and the usefulness of yearly forecast does not significantly differ from that of quarterly forecast in pricing derivatives.

Exhibit III-1. The NPI historical return



2nd Order Autoregression Model

The fact that the NPI is backward looking makes this year's NPI return a good predictor for the NPI return next year. The model that we present here applies one more lag to capture the

[19] We performed the NPI total return prediction based on the same models (see appendix for result) or the NPI total return prediction can simply be obtained by adding historical income return which averages 8% to the predicted capital return.

seasonality of the index. The model has the NPI capital return one year lag and two year lag as independent variables and the NPI capital return as dependent variable.

Let

NPI_t = NPI capital return at time t

Then

$NPI_t = \alpha + \beta * NPI_{t-1} + \gamma * NPI_{t-2}$

The NPI annul returns are available from year 1978 through year 2005. Since the model employs two lags, the sample consists of 26 observations (1980-2005). The result of the autoregression is shown as follows:

Exhibit III-2. 2nd Order Autoregression Result

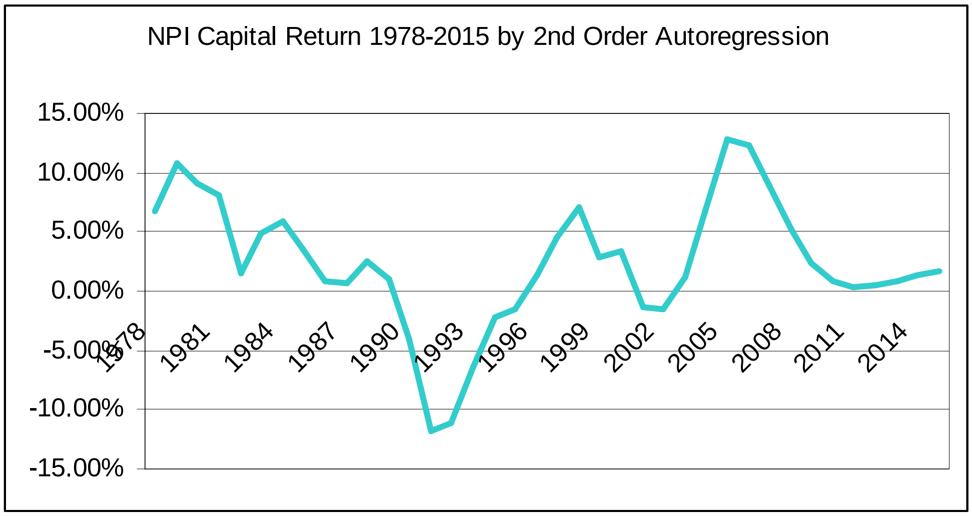
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.0049	0.0067	0.7249	0.4758
NPI_{t-1}	1.1732	0.1936	6.0591	0.0000
NPI_{t-2}	-0.4699	0.1936	-2.4273	0.0235
R-squared	0.6907	Mean dependent var		0.0146
Adjusted R-squared	0.6638	S.D. dependent var		0.0569
S.E. of regression	0.0330	F-statistic		25.6752
Sum squared resid	0.0251	Prob(F-statistic)		0.0000

The model is statistically significant both from T statistics and F statistic perspective and explains 66% of the variance in the NPI according to adjusted R square. From this result, we can find the following formula as our first forecasting model:

$NPI_t = 0.0049 + 1.1732 * NPI_{t-1} – 0.04699 * NPI_{t-2}$

It is easy to see the inertia of the NPI looking at the 1.1732 coefficient of NPI $_{t-1}$. The predicted NPI capital return through year 2015 can therefore be illustrated as shown in the exhibit III-3 below:

Exhibit III-3.



Year	2006	2007	2008	2009	2010
NPI Capital Return	12.29%	8.90%	5.15%	2.35%	0.82%

Vector Autoregression Model (VAR)

The second forecasting model is a four-variable two lag vector autoregression model (VAR). We assume that the NPI not only depends on its own lags, but also the lags of the other variables, namely: MIT/CRE's Transaction-based Index (TBI) return, NAREIT Index Return (REITs) and the NPI yield spread over treasury (NPIYLDSPD). Therefore, in order to forecast the NPI return three periods from now for example, we need to know TBI return, NAREIT return and the NPI yield spread for the next two periods as stipulated by our model. VAR allows for the forecast of multiple dependant variables simultaneously. Although the NPI return is our point of interest, we need forecasts on the other three variables to get a forecast on the NPI return.

The TBI is to measure market movements and returns on investment based on transaction prices of properties sold from the NCREIF Index database. It can often provide a more up-to-date or precise picture of movements in the real estate market and should lead the NPI. The TBI is currently available starting from year 1984. The unsmoothed NPI capital return component is used for years from 1978 to 1983 instead as a substitute for the TBI during the period[20]. The unsmoothed NPI capital return is obtained by applying the following reverse filter (Geltner and Mei (1995)):

$$g_t = (g_t^* - 0.6 g_{t-1})/0.4$$

where g_t^* is the NPI capital return in year t and g_t is the unsmoothed capital return. The REITs returns represented by NAREIT index have also been indicated by several studies as a leading indicator of the NPI. Lastly, the NPI yield spread over treasury is a measure of "expensiveness" of private real estate relative to treasury. When the spread is high, private real estate is relatively cheap and higher capital return should be expected; when the spread is low, private real estate is relatively expensive, lower capital return should be expected.

Let

NPI_t = NPI capital return at time t

TBI_t = TBI capital return at time t

$NAREIT_t$ = NAREIT capital return at time t

$NPIYLDSPRD_t$ = NPIYLDSPRD capital return at time t

Then

$$NPI_t = \alpha + \beta * NPI_{t-1} + \gamma * NPI_{t-2} + \delta * TBI_{t-1} + \varepsilon * TBI_{t-2} + \zeta * NAREIT_{t-1} + \eta * NAREIT_{t-2} + \theta * NPIYLDSPRD_{t-1} + \iota * NPIYLDSPRD_{t-2}$$

[20] In the remaining part of our thesis, we will use the unsmoothed NPI as a substitute for TBI from 1978 to 1983.

The NPI annul returns are available from year 1978 through year 2005. Since the model employs two lags, the sample consists of 26 observations (1980-2005). The result of the VAR is presented in the exhibit III-4.

Exhibit III-4. NPI Vector autoregression result

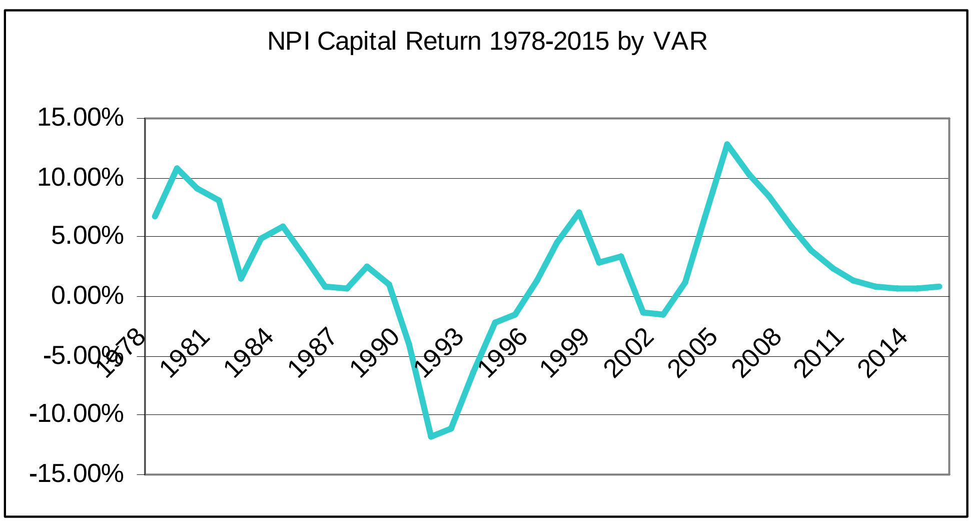
	NPI	TBI	NAREIT	NPIYLDSPRD
NPI $_{t-1}$	1.1274	0.9778	-1.1089	-0.1075
	0.2889	0.5943	1.5790	0.1535
	[3.90284]	[1.64544]	[-0.70228]	[-0.70032]
NPI $_{t-2}$	-0.3026	-0.2225	0.3492	-0.0190
	0.2666	0.5484	1.4572	0.1417
	[-1.13527]	[-0.40564]	[0.23965]	[-0.13430]
TBI $_{t-1}$	-0.1816	-0.4668	0.3738	0.0288
	0.1243	0.2558	0.6796	0.0661
	[-1.46059]	[-1.82524]	[0.54999]	[0.43535]
TBI $_{t-2}$	0.0722	-0.0212	-0.0102	-0.0079
	0.1128	0.2321	0.6167	0.0600
	[0.63972]	[-0.09140]	[-0.01660]	[-0.13143]
NAREIT $_{t-1}$	0.1257	0.2874	0.0105	-0.0087
	0.0441	0.0908	0.2412	0.0234
	[2.84892]	[3.16645]	[0.04364]	[-0.37258]
NAREIT $_{t-2}$	0.0629	0.3255	-0.2787	-0.0099
	0.0486	0.1000	0.2657	0.0258
	[1.29511]	[3.25519]	[-1.04896]	[-0.38362]
NPIYLDSPRD $_{t-1}$	0.2285	0.3454	-1.1520	0.6113
	0.4677	0.9622	2.5566	0.2486
	[0.48846]	[0.35894]	[-0.45060]	[2.45916]
NPIYLDSPRD $_{t-2}$	0.1437	0.6313	1.0280	0.2356
	0.4804	0.9884	2.6263	0.2554
	[0.29912]	[0.63871]	[0.39142]	[0.92275]
C	0.0015	0.0270	0.0745	0.0004
	0.0091	0.0187	0.0497	0.0048
	[0.16970]	[1.44195]	[1.50003]	[0.08443]
R-squared	0.8272	0.6850	0.1443	0.8012
Adj. R-squared	0.7459	0.5368	-0.2585	0.7076
Sum sq. resids	0.0140	0.0592	0.4182	0.0040
S.E. equation	0.0287	0.0590	0.1568	0.0152
F-statistic	10.1749	4.6216	0.3582	8.5617

The first line for each independent variable is its coefficient, the second line its standard error and the third its T statistics. Although the NPI is what we are really interested in, the model also forecasts TBI, NAREIT and NPIYLDSPRD too, since we need forecasts on these variables to forecast the NPI. The VAR model shows significant improvement from the simple autoregression model in adjusted R square (from 0.66 to 0.75). From this result, we can find the following formula as our second forecasting model:

$$NPI_t = 0.0015 + 1.1274 * NPI_{t-1} - 0.3026 * NPI_{t-2} - 0.1816 * TBI_{t-1} + 0.0722 * TBI_{t-2} + 0.1257 * NAREIT_{t-1} + 0.0629 * NAREIT_{t-2} + 0.2285 * NPIYLDSPRD_{t-1} + 0.1437 * NPIYLDSPRD_{t-2}$$

Based on the model, the predicted NPI capital return through year 2015 can be illustrated as the exhibit III-5 below:

Exhibit III-5.



Year	2006	2007	2008	2009	2010
NPI Capital Return	10.34%	8.50%	5.91%	3.81%	2.29%

Forecasting Model Incorporating Expectations

In the last two models, the purpose of our study was to forecast the NPI return using the historical data. They were both autoregression models which do not allow users to incorporate his or her view into the model, and the model thus cannot be used by those who have a different view from what is forecasted by the model. Here in this section, we will develop a relatively simple model that investors can use to transfer their own views on the underlying real estate market to the NPI forecast. There are a few reasons why we think such a simple model can be very useful.

First, investors usually have their own views not on the NPI but on the underlying property market. Second, mainly due to the lagging nature of appraisal based index, the return on the NPI tends to differ quite significantly from the return on the underlying market for a given period. Third, real estate index derivatives currently offered are written on the NPI and therefore, the return from the derivatives may be significantly different from that on the underlying property market.

As a result, if investors price real estate derivatives based on their expectation of the underlying market, the price can be considerably different from the market price since the market price must be based on the expectation of the NPI. From this viewpoint, we believe that investors will need to convert their views on the market into the NPI, which tends to lag the underlying market. Hence we would like to suggest a simple model that investors would be able to take advantage of, when comparing their expectation on the market with what is forecasted by the price of real estate derivatives written on the NPI.

It should be noted, however, that we do not intend to develop a model that may be more accurate and academically valuable but too complicated to be utilized with a simple data set. The purpose of the analysis in this section is to provide a rough but plain estimation tool which investors can use with the data readily available and their own expectation on the market.

First, let us make a few assumptions in developing this simple forecast model.

1. The MIT transaction based index[21] is used as a proxy for the underlying market.
2. The current NPI return not only reflects the current underlying market but also has inertia from the previous NPI return.

Based on these assumptions, we can think of two simple regression models using the current and lagged NPI and TBI

Let

NPI_t = NPI total return at t

TBI_t = TBI total return at t

Then

Model 1.

$NPI_t = \alpha + \beta * NPI_{t-1} + \gamma * TBI_t$

Model 2.

[21] Again, we use the unsmoothed NPI total return for the period between 1978 and 1984

$NPI_t = \alpha + \beta * NPI_{t-1} + \gamma * TBI_t + \delta * TBI_{t-1}$

Using the same NPI and TBI data from 1978 to 2005 we used in the previous section, we run the regression on the two models, and the following results are found.

Exhibit III-6. Model 1 regression result

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000807	0.009842	0.081986	0.9353
NCREIF(-1)	0.632171	0.088692	7.127697	0
TBI	0.340935	0.059405	5.739139	0
R-squared	0.84967	Mean dependent var		0.098685
Adjusted R-squared	0.837143	S.D. dependent var		0.06383
S.E. of regression	0.025759	Akaike info criterion		-4.37563
Sum squared resid	0.015925	Schwarz criterion		-4.23165
Log likelihood	62.07102	F-statistic		67.82462
Durbin-Watson stat	1.752011	Prob(F-statistic)		0

Exhibit III-7. Model 2 regression result

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000552	0.010036	0.054989	0.9566
NCREIF(-1)	0.598855	0.12108	4.945929	0.0001
TBI	0.338544	0.060736	5.574029	0
TBI(-1)	0.036744	0.089004	0.412838	0.6835
R-squared	0.850776	Mean dependent var		0.098685
Adjusted R-squared	0.831312	S.D. dependent var		0.06383
S.E. of regression	0.026216	Akaike info criterion		-4.30894
Sum squared resid	0.015807	Schwarz criterion		-4.11696
Log likelihood	62.17069	F-statistic		43.71031
Durbin-Watson stat	1.723892	Prob(F-statistic)		0

In the model 2, the t-value of the lagged TBI indicates that the variable is not statistically significant in forecasting the NPI. Moreover, adjusted R-squared value also suggests that we use the model 1 rather than the model 2. From this result, we can find the following formula as our simple forecasting model.

$$NPI_t = 0.0008 + 0.6322 * NPI_{t-1} + 0.3409 * TBI_t$$

In order to illustrate how to use this forecasting model, we can consider a simple example. Let us assume an investor who expects the yearly return on the real estate market from 2006 to 2008 to be 12%, 8%, and 5%, respectively. Since we assume that the TBI total return is the proxy for the total return on the underlying property market, we input the expected total return instead of TBI in order to forecast the NPI. The resulting forecast is tabulated in the exhibit III-8 .

Exhibit III-8. Sample forecast using the forecast model incorporating expectation

	Return on the underlying market		NPI total return
2005	34.16%[22]		20.16%[23]
2006	12.00%	0.0008+0.6322*0.2016+0.3409*0.12=	16.92%
2007	8.00%	0.0008+0.6322*0.1692+0.3409*0.08=	13.50%
2008	5.00%	0.0008+0.6322*0.1350+0.3409*0.05=	10.32%

It is noteworthy that the NPI total return forecasted by our model is significantly different from the underlying expectation. It is partly due to the inaccuracy of our model in converting the expected return on the underlying market into the NPI return. We believe, however, that the discrepancy is mainly caused by the inertia in the appraisal based index.

[22] MIT TBI total return in 2005
[23] NPI total return in 2005

Now let us verify the accuracy of our model by back-testing it using the historical data. While the previous model is built on the data taken from the period of 1978-2005, here we build another model using the same method but a different data set, now taken from 1978 to 1998. The new model based on the new set of data is as follows:

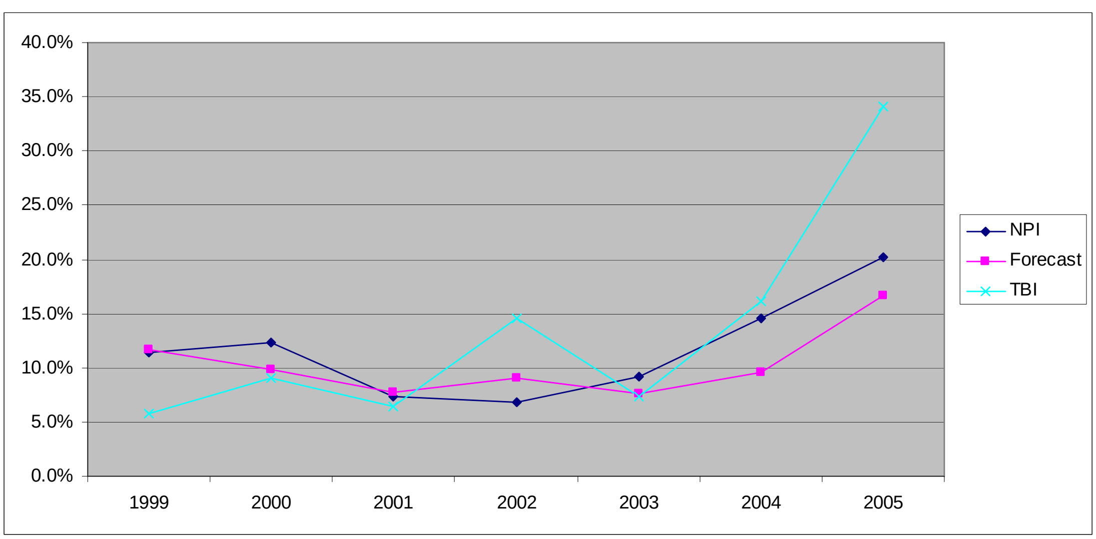
$NPI_t = -0.0077 + 0.6521 * NPI_{t-1} + 0.3291 * TBI_t$

Again, we assume that the MIT TBI total return is the proxy for the underlying property market return. In addition, it is assumed that the expectation on the underlying market return was exactly same as the TBI total return from 1999 to 2005. This back-testing analysis shows the following result, which is also graphically presented in the exhibit III-10.

Exhibit III-9 Back-testing result on yearly return (1999-2005)

	1998	1999	2000	2001	2002	2003	2004	2005
TBI	13.46%	5.77%	9.01%	6.42%	14.60%	7.35%	16.19%	34.16%
NPI – real	16.24%	11.37%	12.31%	7.35%	6.80%	9.20%	14.61%	20.16%
NPI – forecast		11.72%	9.84%	7.76%	9.10%	7.59%	9.51%	16.68%

Exhibit III-9 Back-testing result



The forecasted NPI closely follows the realized the NPI although it still shows relatively significant divergence from the real NPI in some years. Since what may be more meaningful in trading derivatives is the average return during the investment horizon of derivative contract, another analysis can be carried out to compare the average return over three-year period, a typical maturity of real estate index swap currently traded in U.K. The result of the analysis presented in the exhibit III-11 confirms that our simple forecast model is a fairly useful tool for investors to approximate the expected NPI total return based on their expectation especially over the lifetime of a derivative contract.

Exhibit III-11. Back-testing result on three-year average return

	1998-2000	1999-2001	2000-2002	2001-2004	2002-2005
TBI	7.06%	9.96%	9.40%	12.65%	18.72%
NPI - real	10.32%	8.79%	7.78%	10.16%	14.57%
NPI - forecast	9.76%	8.90%	8.15%	8.73%	11.19%
Difference	-0.56%	0.11%	0.37%	-1.43%	-3.38%

As we set forth in the beginning of this section, this simple model is designed as a tool that can be used with easily accessible data and individual investor’s view on the market. Although the outcome of this model may not be accurate enough to provide the forecast determining the precise price of real estate derivatives, the importance of this model can still be found in a sense that this analysis let investors contemplate the divergence between the underlying real estate market and the NPI in executing real estate derivatives written on the index.

Chapter Four: Pricing of Real Estate Derivatives

In this chapter, we are discussing arguably the most important issue in real estate derivative: pricing. The literature on pricing methods of real estate derivatives is somewhat limited. Buttimer, Kau and Slawson (1997) develop a two-state model for pricing derivatives written on a real estate index and an interest rate. Using a bivariate binomial mode, the authors value a commercial real estate index lined swap and conclude that swap's value is positive, although near zero. Bjork and Clapham (2002) show that the model developed by Buttimer et al. has some limitation and that the price of the swap is zero by using an arbitrage-free framework. Patel and Pereira (2006) extend the model and find that real estate index total return swap price is no longer zero if counterparty default risk is considered.

In our analysis, we are using two fundamental pricing methodologies: arbitrage analysis and equilibrium analysis. Arbitrage analysis is based on simple principle that assets with the same cash flows must have the same value. Equilibrium analysis is based on the principle that the return on an asset must be commensurate to its risk. Price here is defined as the return an investor pays to receive the NPI return from the viewpoint of long side; from short side perspective, it is the return the NPI return is sold for. The NPI total return swap is mainly analyzed in applying both analyses as it is the most basic and widely accepted form of real estate index swap.

Arbitrage analysis

The simplest approach to analyzing the pricing of the real estate index swap is to use arbitrage analysis based on the classical "Futures-Spot Parity Theorem". In order to price real estate index derivatives using an arbitrage analysis, we first need to make the following assumptions.

- It is possible to create a portfolio that has the same return as NPI
- An investor can hold and buy or sell (including short-sell) the portfolio without any transaction cost.
- There is neither counterparty risk nor transaction cost

Although it is virtually impossible to apply these assumptions to reality, it is still worthwhile to discuss this arbitrage analysis method. It enables us to derive a simple pricing model, which can be used as a commencing point for the further discussion on the pricing of real estate index derivatives. Here we will focus on the pricing of the NPI total return swap and briefly discuss that of property type swap among the products currently offered by Credit Suisse.

NPI Total Return Swap

If we assume that it is possible to create a portfolio that has the same return as the NPI total return and to effectively trade the portfolio, we can construct a riskless hedge using the underlying portfolio and the NPI total return swap contract. For simplicity, let us begin the analysis by constructing a two-period riskless hedge, and consider the following strategy starting at time t and ending at time t+2.

Let:

V_t = The value of the underlying portfolio at time t

I_t = NPI total return (Sum of capital appreciation return and income return) during the period from t-1 to t

F = The fixed spread in the fixed leg of NPI total return swap

r_n = Zero coupon bond yields (discount rate) for n-period(s) starting at t

Then:

At time t,

- buy the underlying portfolio and pay V_t
- go short (pay NPI total return and receive a fixed spread) in the NPI total return swap with the notional amount of V_t
- Issue a zero with a par value of FV_t for one period at the interest rate of r_1
- Issue a zero with a par value of $V_t + FV_t$ for two periods at the interest rate of r_2

At time t+1,

- Pay $I_{t+1}Vt$ to the counterparty of the swap transaction and receive the same amount from the underlying portfolio transaction.
- Repay FV_t for the zero issued for one-period and receive the same amount from the counterparty of the swap transaction

At time t+2,

- Sell the underlying portfolio and receive $I_{t+2}V_t + V_t$
- Pay $I_{t+2}Vt$ and receive FV_t in the total return swap contract
- Repay $V_t + FV_t$ for the zero issued for two periods

The cash flows from the trading strategy are presented in the exhibit below.

Exhibit IV-1. Cash flow of arbitrage analysis on the NPI total return swap

	Cash Flow at t	Cash Flow at t+1	Cash Flow at t+2
Buy the underlying portfolio	$-V_t$	$I_{t+1}Vt$	$I_{t+2}V_t + V_t$
Short in total return swap	0	$-I_{t+1}Vt + FV_t$	$-I_{t+2}Vt + FV_t$
Issue zero for 1 period	$\frac{FV_t}{(1+r_1)}$	$-FV_t$	
Issue zero for 2 periods	$\frac{(V_t + FV_t)}{(1+r_2)^2}$		$-V_t - FV_t$
Total	$-V_t + \frac{FV_t}{(1+r_1)} + \frac{(V_t + FV_t)}{(1+r_2)^2}$	0	0

We can easily find that the following condition should hold for there to be no arbitrage in this trading strategy,

$$-V_t + \frac{FV_t}{(1+r_1)} + \frac{(V_t + FV_t)}{(1+r_2)^2} = 0 \qquad (4\text{-}1)$$

If we solve the formula above for F, then we can find that

$$F = \frac{(r_2^2 + 2r_2) \times (1+r_1)}{r_2^2 + 2r_2 + r_1 + 2}$$

It should be noted that the fixed spread, F , is independent of the NPI total return, I_t. It is determined only by the zero coupon yields, r_1 and r_2, which are effectively the borrowing costs of an investor.

Before we expand this two-period model into a more general, multi period one, let us take a look at another trading strategy using a typical plain vanilla interest rate swap (IRS) where a fixed spread is exchanged for LIBOR at each period without initial or final principal exchange. We can easily construct a riskless hedge portfolio using this interest rate swap, a floating rate bond, and zero coupon bonds.

Let:

V = Notional amount of the swap contract

L_t = LIBOR for the period from t-1 to t

F' = Fixed spread in the fixed leg of plain vanilla interest rate swap

r_n = Zero coupon bond yields for n-period(s) starting at t

Let us consider a trading strategy similar to what we have analyzed for real estate derivatives pricing. First, invest V at LIBOR (buying floating rate bonds) for two periods. Then, enter into an IRS contract where we pay LIBOR and receive fixed with the notional amount of V and the maturity of T+2 (Two periods). In order to construct the riskless hedge, issue two zero coupon bonds for one period and two periods at the interest rate of r_1 and r_2, respectively, so that the cash flows from the zero coupon bonds can offset those from the floating rate bond and the swap. The cash flows from this strategy are presented in the exhibit IV-2.

Exhibit IV-2. Cash flow of arbitrage analysis on interest rate swap

	Cash Flow at t	Cash Flow at t+1	Cash Flow at t+2
Invest at LIBOR	$-V$	$L_{t+1}V$	$L_{t+2}V+V$
Receive Fixed in IRS	0	$-L_{t+1}V+F'V$	$-L_{t+2}V+F'V$
Borrow for 1 period	$\frac{F'V}{(1+r_1)}$	$-F'V$	
Borrow for 2 periods	$\frac{(V+F'V)}{(1+r_2)^2}$	0	$-V-F'V$
Total	$-V+\frac{F'V}{(1+r_1)}+\frac{(V+F'V)}{(1+r_2)^2}$	0	0

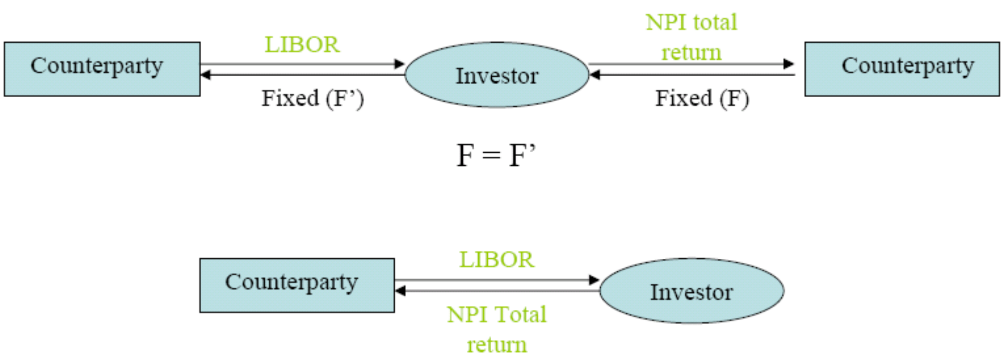
For no arbitrage to exist in this strategy, the following condition should hold from this trading strategy,

$$-V+\frac{F'V}{(1+r_1)}+\frac{(V+F'V)}{(1+r_2)^2}=0 \qquad (4\text{-}2)$$

$$F'=\frac{(r_2^2+2r_2)\times(1+r_1)}{r_2^2+2r_2+r_1+2}$$

Comparing this formula (4-2) with the formula (4-1) that we derived from the real estate derivatives riskless trading strategy, we find that the fixed spreads of two swaps, F and F', are the same since same zero coupon yields (borrowing costs) can be used in both trading strategies for a given investor. We already know that F' is the fixed leg of plain vanilla interest rate swap for the investor whose borrowing costs are r_1 and r_2. Therefore, we can conclude that, if an investor who wants to invest in the NPI total return swap has the access to the interest rate swap market, the fixed spread s/he needs to pay or receive in return for the NPI total return will be same as that in the interest rate swap with the same maturity. Furthermore, by combining the NPI total return swap and a plain vanilla interest rate swap[24] so that the fixed spreads of two swaps can offset each other as presented in the exhibit IV-3 below, we find that the price for the NPI total return swap is in fact LIBOR.

Exhibit IV-3 Converting fixed into floating using interest rate swap



Now let us expand this simple two-period model to a more general multi-period model and find that the pricing relationship that we have found in the two-period model also holds for multi-period.

Expand both models to n-periods and the formula (4-1) and (4-2) are changed to the following formulas, respectively.

[24] Either a combination of interest rate swap where an investor pays fixed and NPI total return swap where the investor receives fixed or that of interest rate swap where fixed is received and NPI total return swap where fixed is paid.

$$-V_t + \frac{FV_t}{(1+r_1)} + \frac{FV_t}{(1+r_2)^2} + \frac{FV_t}{(1+r_3)^3} + \Lambda + \frac{(V_t + FV_t)}{(1+r_n)^n} = 0 \qquad (4\text{-}1a)$$

$$-1 + F\left[\sum_{i=1}^{n} \frac{1}{(1+r_i)^i}\right] + \frac{1}{(1+r_n)^n} = 0$$

$$F = \frac{\left[1 - \frac{1}{(1+r_n)^n}\right]}{\left[\sum_{i=1}^{n} \frac{1}{(1+r_i)^i}\right]}$$

$$-V + \frac{F'V}{(1+r_1)} + \frac{F'V}{(1+r_2)^2} + \frac{F'V}{(1+r_3)^3} + \Lambda + \frac{(V + F'V)}{(1+r_n)^n} = 0 \qquad (4\text{-}1b)$$

$$-1 + F'\left[\sum_{i=1}^{n} \frac{1}{(1+r_i)^i}\right] + \frac{1}{(1+r_n)^n} = 0$$

$$F' = \frac{\left[1 - \frac{1}{(1+r_n)^n}\right]}{\left[\sum_{i=1}^{n} \frac{1}{(1+r_i)^i}\right]}$$

Although the formulas are extended to multi periods, comparing these two formulas indicates that the pricing relationship that F equals to F’ is still satisfied. Therefore, we can conclude that, even in multi-periods, the fixed spread for the NPI total return swap equals to that of plan vanilla interest rate swap with the same maturity and therefore, the price of the NPI total return swap is LIBOR.

NPI Property Type Swap

Again, let us assume that we can construct a portfolio that has the same return as each NPI property type total return for a given property type. Using this underlying portfolio and the NPI property type swap, we can create a riskless hedge.

For example, let us consider a property type swap where an investor pays the NPI office total return and receives the NPI retail total return plus a fixed spread.

Let:

V_t = The value of the portfolio at time t (Please note that the value of office portfolio is same as that of retail portfolio at time t)

I_t^O = Total return of the NCREIF office index during the period from t-1 to t

I_t^R = Total return of the NCREIF Retail index during the period from t-1 to t

F = The fixed spread to be paid (received in case F is negative)

A riskless trading strategy for two periods can be structured as follows,

At time t,

- Sell(short-sell) the office portfolio for V_t
- Buy the retail portfolio at V_t
- Enter a property type swap where the return on the NCREIF office index is received and the return on the NCREIF retail index with a fixed spread is paid for two periods.

At time t+1,

- Pay the return on the office portfolio, receive the return on the retail portfolio, and exchange the cash flows resulting from the property type swap.

At time t+2,

- Buy back the office portfolio, sell the retail portfolio, and exchange the cash flows resulting from the property type swap.

The cash flows from these transactions are presented in the exhibit below.

Exhibit IV-4. Cash flow of arbitrage analysis on the NPI property type swap

	Cash flow at t	Cash flow at t+1	Cash flow at t+2
Short the Office Portfolio	V_t	$-I_{t+1}^{O}V_t$	$-I_{t+2}^{O}V_t - V_t$
Long the Retail Portfolio	$-V_t$	$I_{t+1}^{R}V_t$	$I_{t+2}^{R}V_t + V_t$
Property Type Total Return Swap	0	$I_{t+1}^{O}V_t - I_{t+1}^{R}V_t - FV_t$	$I_{t+2}^{O}V_t - I_{t+2}^{R}V_t - FV_t$
Total	0	$-FV_t$	$-FV_t$

In order to have no arbitrage from this riskless hedge, the following condition must be satisfied, which requires the fixed spread of the swap, F, to equal to zero.

$$0 - \frac{FV_t}{(1+r_1)} - \frac{FV_t}{(1+r_2)^2} = 0 \tag{4-3}$$ [25]

[25] The discount rates, r_1 and r_2 are the borrowing costs of a given investor

Also in the multi-periods model, F must equal to zero in order to satisfy the following condition.

$$0-\frac{FV_t}{(1+r_1)}-\frac{FV_t}{(1+r_2)^2}-\frac{FV_t}{(1+r_3)^3}-\Lambda-\frac{FV_t}{(1+r_n)^n}=0$$

$$F\left[\sum_{i=1}^{n}\frac{1}{(1+r_i)^i}\right]=0 \qquad \text{(4-3a)}$$

Therefore, we can conclude that the NPI property type swap does not require any fixed spread to be paid or received in addition to the NPI return on each property type under the assumptions we made in the beginning.

Equilibrium analysis

Although the arbitrage analysis provides the foundation for pricing real estate index derivatives, the assumptions made in the analysis are too strict and unrealistic. For example, it is impossible to go short in the underlying property market, which does not allow the arbitrage pricing relationship to force the price of real estate derivatives to return to the fair value. Therefore, here in this section, we would like to suggest a more intuitive pricing method through equilibrium analysis, which is based on the basic principal that the expected total return risk premium per unit of risk should be constant within and across the relevant asset markets.

Suppose there are two investors, A and B, who consider making investment in the NPI total return swap. Investor A currently has an investment in real estate portfolio which yields the market expected return on the overall real estate market, and would like to reduce the exposure in real estate. Investor B has an existing investment in a risk free asset and considers investing in real estate. From the viewpoint of investor A, going short in the NPI total return swap can be attractive as a quick and easy way to reduce the exposure in real estate. On the other hand, investor B, who does not have any expertise in real estate, finds going long in the NPI capital value return swap as a good alternative to investing directly in a real estate asset, since the swap helps achieving more diversification as the NPI covers a broad market. In addition, low transaction cost is another factor to make both investors prefer investing in the swap to using the property market. As a result, both investors agree to make a swap contract where investor A pays the NPI total return and receives a fixed spread while investor B receives the NPI total return and pays the fixed spread.

Let:

$E^A[r_{NPI}] =$ Investor A's expectation of the NPI's average total return over the lifetime of the swap contract

$E^B[r_{NPI}] =$ Investor B's expectation of the NPI's average total return over the lifetime of the swap contract

$E[r\ ] =$ The market's expected total return on the real estate portfolio over the lifetime of the swap contract

$E[RP_{NPI}] =$ The market's required risk premium on the expected NPI total return

$E[RP] =$ The market's required risk premium on the expected total return on the real estate portfolio

$r_f =$ The risk free rate over the lifetime of the swap contract

$F =$ The fixed leg of the swap contract

By analyzing the risk for each investor, which results from the swap and the existing investment, as well as the required return to compensate the risk, we can find the following risk-return relationships.

From investor A's perspective, the overall return from the new portfolio is the expected total return on the real estate portfolio plus the fixed spread minus the expected NPI total return. In addition, the swap allows investor A to replace the risk on the real estate portfolio with the risk on the fixed spread, which is virtually riskless. Therefore, investor A requires,

$$E\ [r] + F - E^{A}[r_{NPI}] \geq r_f \tag{4-4}$$

Investor B, whose overall return is the expected NPI total return minus the fixed spread plus the return from the existing risk-free investment, now requires,

$$E^{B}[r_{NPI}] - F + r_f \geq r_f + E[RP_{NPI}] \tag{4-5}$$

The fixed spread, F, is the price of the swap and should be determined so that these two inequalities can be both satisfied. If we rearrange these two inequalities to solve for F, the following condition must be fulfilled.

$$F \geq E^{A}[r_{NPI}] - E[r] + r_{f}$$
$$F \geq E^{A}[r_{NPI}] - E[RP] - r_{f} + r_{f}$$
$$F \geq E^{A}[r_{NPI}] - E[RP]$$
$$F \leq E^{B}[r_{NPI}] - E[RP_{NPI}]$$
$$E^{A}[r_{NPI}] - E[RP] \leq F \leq E^{B}[r_{NPI}] - E[RP_{NPI}]$$

If we assume that $E[RP]$ equals to $E[RP_{NPI}]$[26], which intuitively makes sense as they are based on the same underlying market, both investors can find the price, F, that meets the condition set forth above as long as $E^{B}[r_{NPI}]$ is higher than $E^{A}[r_{NPI}]$. Furthermore, if both investors have the same expectation on the NPI total return, $E[r_{NPI}]$, the price of the swap, F, can be expressed as follows,

$$F = E[r_{NPI}] - E[RP_{NPI}] \qquad (4\text{-}6)$$

In a market at its equilibrium, $E[r_{NPI}]$ equals to $r_{f} + E[RP_{NPI}]$. And therefore,

$$F = r_{f}$$

This result is in line with the result of the arbitrage analysis where we found that the price of the NPI total return swap equals to risk-free rate (LIBOR). When the market is in disequilibrium, however, the price of the swap is determined by the market's expectation on the NPI total return over the lifetime of the swap contract as presented in the formula (4-6) above. Therefore, if the

[26] Based on the long term government bond yield (Ibbotson SBBI), the historical average risk premium on MIT TBI total return (1978-2005) is 312BPs and that on NPI total return (1978-2005) is 215BPs.

market expects the NPI total return over the swap contract horizon to be higher than the market equilibrium level, there will be a positive spread over LIBOR to be exchanged with the NPI total return, and vice versa.

Theoretical Pricing vs. Actual Pricing

The preceding sections illustrated how real estate derivatives should be priced based on fundamental finance theory. According to the equilibrium pricing model, total return swap should be priced at the expected return on real estate index minus the market's required risk premium. It is difficult to verify whether the actual market price of real estate derivatives is in line with this theoretical pricing method since the expectation varies significantly.

For example, let us take a look at the UK property derivatives market, which is far more advanced than that in the U.S. Given that the market risk premium of the IPD all-property total return is about 4%[27], the market price of 3-year IPD all-property total return swap in the exhibit IV-5 indicates that the expected total return for the IPD all-property index is approximately 12%[28] for the next three years according to the equilibrium pricing method. However, the wide range of forecasts from various institutions tabulated in the exhibit IV-6 makes it difficult to prove the consistency between the theoretical price and the actual price of the IPD total return swap.

[27] The risk premium is calculated based on the long term US government bond yield (Ibbotson SBBI) and the IPD annual total return (1978-2004)
[28] The 3-month LIBOR was approximately 4.9% and the 3-year IRS rate was around 5.1% on average in March 2006

Exhibit IV-5. Indicative Pricing of IPD swaps, March 2006

IPD Total Return Swap Consensus Pricing

Term: 2 3/4 Year to Dec 31st, 2008

	Spread over LIBOR (bps)	Spread over All Property Index (bps)
All Property	310	-
City Offices	530	220
West End Offices	530	220
Rest UK Offices	380	70
Industrial	290	-20
Retail Warehouses	340	30
Shopping Centers	160	-150
Unit Shops	140	-170

* Source: Hermes Property Derivatives Trading Forum

Exhibit IV-6. UK Property total return forecast

	2006	2007	2008
IPF consensus forecast[29]	13.4%	7.5%	6.3%
Schroder Property Investment[30]	12.9%	7.9%	4.2%
RICS[31]	17.4%	8.6%	N/A
EuroHypo[32]	12.9%		

Market participants have articulated several explanations about the factors that could affect the pricing of real estate index derivatives and make the actual pricing differ from the purely theoretical pricing. First, current pricing in practice may still be purely return based. If investors believe that the index is going to average 10% return for the next two years, they also demand 10% return if they were to short the index total return. The change in the risk profile due to the swap is not taken into consideration in this pricing method. Same story goes with property type

[29] IPF Consensus Forecasts, A Guide to the Property Outlook, May 2006
[30] UK Property Viewpoint, March 2006
[31] Commercial Property Forecasts 2006/2007, April 2006
[32] Sector Swaps, Property Derivatives World, Oct 2005

swap. If investors believe that the office index is going to out perform the industrial index by 50 bps per quarter, they may simply want 50 bps in addition to the industrial index return in case they go short in the office index.

The second explanation is that the investors achieve significant savings in executing their trading or investment strategies via swaps and the savings thus are reflected in the price of the swaps. These savings include not only transaction fee, but potentially management fee to manage the physical properties[33]. In addition, if real estate derivatives are considered a more liquid way to invest in real estate compared to the underlying property market, the price may take account of a liquidity premium too.

Lastly, the lagging nature of the index may be responsible too. Since there is so much inertia in the appraisal based index, investors would have a rough idea on where the index would be in the next 6 to 12 months. In other words, there are some "guaranteed" returns from the appraisal based index. This predictability lowers the risk associated with the index return to a certain extent and investors thus may demand a different return from what the price would be without such predictability.

At the current stage of the market, the pricing seems to be considerably driven by supply and demand in the marketplace. After all, it is not surprising to find that, if more people want to long the index, it pushes the price higher and that, if more people are shorting the index, it pushes the price down. To this end, the expectations of the index or the underlying market would be

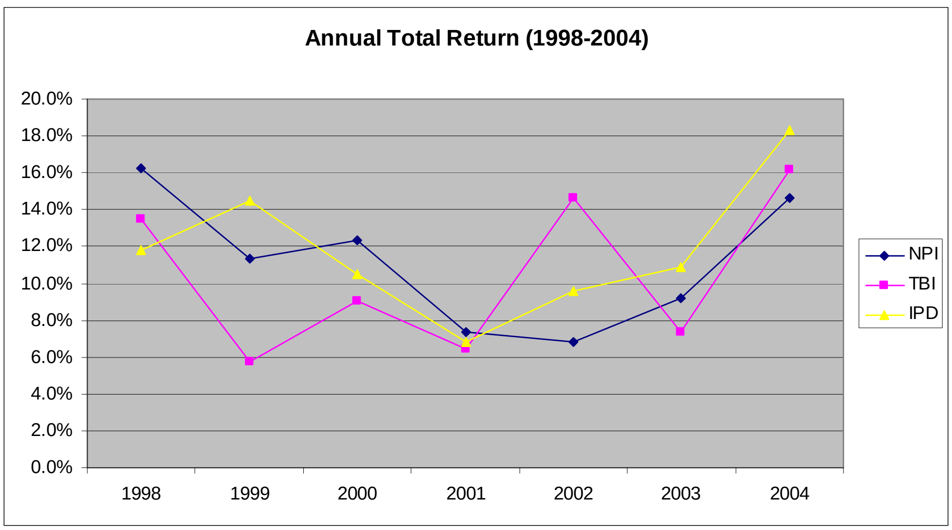
[33] For example, Those investors who go long in NPI swap essentially pay no management fee while making the NPI equivalent return if the fixed spread is priced at the theoretical level.

ultimately fully reflected in the price. Moreover, when large enough number of participants are present and the consensus view formed by them determines the price, the price of derivatives may eventually lead the underlying real estate market.

Chapter Five: Sample Trading

So far we have discussed majority of the issues related to real estate index derivatives. As the last step before we wrap up our discussion, here we will present a sample hypothetical transaction to help investors understand how this product can be used to enhance the performance of their investment.

Exhibit V-1.



The exhibit 5-1 depicts the movement of three different real estate indices from 1998 to 2004. The NPI and the TBI represent the appraisal based and the transaction based return measure in the US real estate market, respectively, while the movement of the IPD all-property index outlines the performance of overall real estate market in the UK. We can find from the graph that the real estate markets in two countries have seen a significant volatility in the recent years. Out of this volatile period, we set the period from 2000 to 2002 as the investment horizon for our sample transaction. As no real estate index swap was available at the beginning of the said period, all the details of the transaction discussed here will be purely hypothetical except the returns, which are taken from each index during the period.

Suppose that there were two investors, investor A and investor B, each managing a real estate portfolio in the U.S. and the UK, respectively. At the end of 1999, investor A, whose portfolio had been heavily weighted in real estate, decided to reduce its exposure on real estate by $100 million for about three years. The investor believed that it would be more efficient to go short in the NPI total return swap rather than to sell the properties and buy them back in three years. After consulting a few investment banks, investor A found that the market mid-price[34] for 3-year NPI total return swap would be 2.375% quarterly. Given that the NPI annual total return for 1999 was 11.4%, this price was viewed by market participants fairly rational. The investor, however, thought that it was overvalued and that there could be a chance to make an extra return from trading this derivative in addition to achieving the initial goal to reduce the real estate exposure in the portfolio. As a result, investor A decided to go short in the NPI total return swap, and agreed on the following terms of trade with an investment bank.

- Notional amount: USD 100 million
- Maturity: 3 years
- Floating leg: NPI total return (quarterly)
- Fixed leg: 2.35%[35] (quarterly)
- Index publish date: the 25th calendar day following the end of the business quarter
- Fixing date: one business day after the publish date
- Payment date: three business days after the fixing date
- Trade date: Jan 28th, 2000
- Effective date: Jan 31st, 2000
- Termination date: Jan 29th, 2003

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[34] Fixed spread exchanged for NPI total return

[35] 2.5 bps lower than the mid price due to the spread charged by the investment bank

Now let us analyze the ex-post return of investor A's portfolio over the lifetime of the swap contract. First, the investor made the return from the existing portfolio[36]. Then, from the swap contract, investor received 2.35% every quarter while paying the quarterly NPI total return[37]. The net cash flows from this portfolio are presented in the exhibit below[38]. If we assume the return on reinvestment of net cash flows to be 2% quarterly, the ex-post annualized total return of this trading strategy for three-year period is 10.32%, 68bps higher than the return that investor A could have earned without going short in the 3-year NPI total return swap. Taking a closer look at the cash flow as well as the exhibit 5-1 reveals that the extra return did come from the correct expectation of investor A on the NPI total return.

Exhibit V-2. Cash flow of investor A's portfolio

Period	Year	Qtr	Existing Potfolio		NPI Total Return Swap			Total Cash Flow	FV at Termination	
			TBI	Cash Flow	NPI	Fixed	Cash Flow		W/O Swap	With Swap
1	2000	1	2.18%	$2,179,152	2.41%	2.35%	($55,918)	$2,123,233	$2,709,501	$2,639,974
2	2000	2	2.18%	$2,179,152	3.07%	2.35%	($723,401)	$1,455,751	$2,656,374	$1,774,552
3	2000	3	2.18%	$2,179,152	2.96%	2.35%	($607,342)	$1,571,810	$2,604,288	$1,878,458
4	2000	4	2.18%	$2,179,152	3.34%	2.35%	($990,425)	$1,188,727	$2,553,224	$1,392,783
5	2001	1	1.57%	$1,567,488	2.38%	2.35%	($32,876)	$1,534,612	$1,800,551	$1,762,787
6	2001	2	1.57%	$1,567,488	2.48%	2.35%	($125,739)	$1,441,749	$1,765,246	$1,623,643
7	2001	3	1.57%	$1,567,488	1.61%	2.35%	$735,849	$2,303,336	$1,730,633	$2,543,070
8	2001	4	1.57%	$1,567,488	0.69%	2.35%	$1,660,104	$3,227,591	$1,696,699	$3,493,649
9	2002	1	3.47%	$3,466,358	1.51%	2.35%	$837,106	$4,303,464	$3,678,527	$4,566,871
10	2002	2	3.47%	$3,466,358	1.62%	2.35%	$727,276	$4,193,634	$3,606,399	$4,363,057
11	2002	3	3.47%	$3,466,358	1.80%	2.35%	$548,591	$4,014,949	$3,535,685	$4,095,248
12	2002	4	3.47%	$3,466,358	1.70%	2.35%	$651,679	$4,118,036	$3,466,358	$4,118,036
							Total Cash Flow		$31,803,485	$34,252,128
							Annual Return		9.64%	10.32%

While investor A considered going short in the NPI total return swap, across the Atlantic Ocean, investor B in London was looking into the possibility of international diversification of the real estate portfolio using real estate index swaps. As s/he did not feel comfortable with acquiring a

[36] Here we assume that the return on the existing real estate portfolio was same as MIT TBI. Also, we converted the annual TBI total return to quarterly returns for our analysis

[37] For example, for the second period in the exhibit, the net cash flow from the swap can be calculated in the following way:

$100,000,000 * (0.0235-0.0307) = -$723,401

[38] We ignored the actual payment date and the accrual period in calculating the payment for simplicity purpose.

single asset in the US mainly due to the lack of expertise in the real estate market there, the investor decided to use the NPI total return swap. Also, s/he chose to go short in the IPD all-property total return swap as a means to decrease the allocation level in the UK real estate market. With the robust 14.5% annual IPD all-property return[39] in 1999, the 3-year IPD all-property total return swap was traded at 2.6% quarterly. Investor B entered into this swap for $100 million by paying the IPD total return[40] and receiving 2.6% fixed every quarter for three years until the beginning of 2003. In addition, the investor went long in the 3-year NPI total return swap with $100 million notional. Although the counterparty of the swap was again an investment bank, who then charged 2.4% quarterly[41] for the fixed spread, Investor B effectively took the opposite side of the deal that investor A made. The cash flows[42] and the ex-post return[43] from these swap transactions to investor B are presented in the exhibit 5-3[44].

By entering into two real estate index swaps that had different markets as underlying, investor B not only achieved the targeted international diversification without incurring any significant transaction cost but also earned additional 86bps annually during the three year investment horizon of the swaps.

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[39] IPD Annual Index 2005

[40] Although there was no quarterly IPD index available during the said period, we used quarterly returns converted from the annual IPD total return for our analysis

[41] Although the terms of the swap are same as the one that investor A entered into except the side, the price is different due to the bid-offer spread charged by an investment bank as a facilitator. This bid-offer spread can vary depending on the market situation.

[42] The net cash flow is calculated in the following way:
Cash flow = Notional amount * [Fixed (IPD swap) – IPD return + NPI return – Fixed (NPI swap)].
For the second period, for example,
$745,853 = $100,000,000 * [2.6%-2.53%+3.07%-2.4%]

[43] Again, we assume 2% quarterly as the reinvestment return.

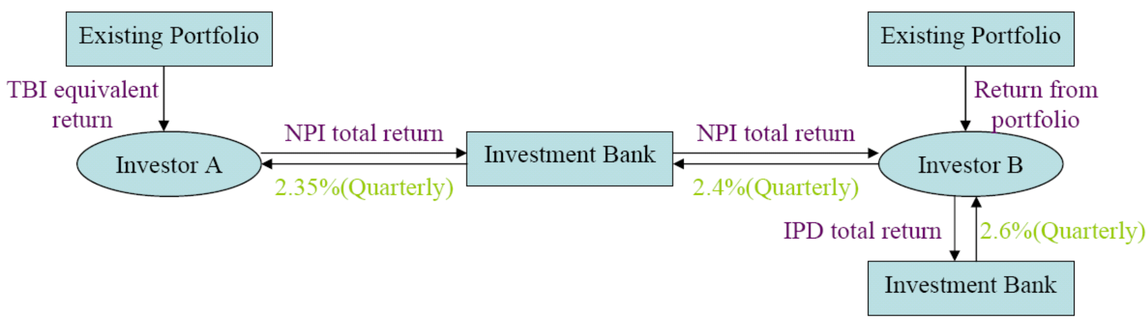
[44] IPD publishes the return at 3pm on the 10th working day after the corresponding business period. Accordingly, the payment schedule for the IPD index swap is different from that of the NPI swap. However, here we ignore the difference in the payment dates and the accrual period for simplicity.

Exhibit V-3. Cash flow of investor B's swap position

Period	Year	Qtr	IPD	Fixed	NPI	Fixed	Cash Flow	FV
1	2000	1	2.53%	2.60%	2.41%	2.40%	$78,371	$97,444
2	2000	2	2.53%	2.60%	3.07%	2.40%	$745,853	$909,191
3	2000	3	2.53%	2.60%	2.96%	2.40%	$629,794	$752,663
4	2000	4	2.53%	2.60%	3.34%	2.40%	$1,012,878	$1,186,748
5	2001	1	1.66%	2.60%	2.38%	2.40%	$924,582	$1,062,055
6	2001	2	1.66%	2.60%	2.48%	2.40%	$1,017,446	$1,145,809
7	2001	3	1.66%	2.60%	1.61%	2.40%	$155,858	$172,080
8	2001	4	1.66%	2.60%	0.69%	2.40%	($768,397)	($831,737)
9	2002	1	2.32%	2.60%	1.51%	2.40%	($605,247)	($642,293)
10	2002	2	2.32%	2.60%	1.62%	2.40%	($495,416)	($515,431)
11	2002	3	2.32%	2.60%	1.80%	2.40%	($316,732)	($323,066)
12	2002	4	2.32%	2.60%	1.70%	2.40%	($419,819)	($419,819)
							Total Cash Flow	$2,593,643
							Annual Return	0.86%

In this trading simulation, both investors not only achieved their targeted asset reallocation but also enhanced their return by using real estate index swaps. The graphical illustration of these sample trades is presented in the exhibit V-4 below.

Exhibit V-4. The overview of sample trades



Although the trades we have discussed are highly stylized, we believe that these two examples well illustrate how investors with different needs and views on the market can benefit from using real estate index derivatives. After all, the price of real estate index derivatives will be driven by the demand and supply from different type of investors such as hedgers, speculators, and arbitrageurs, and thus there will always be a profitable investment opportunity depending on the price level of the derivatives.

Chapter Six: Conclusion

Real estate derivatives are a natural development of an increasingly sophisticated and institutionalized commercial real estate asset class. We demonstrate that real estate derivatives would allow investors to achieve asset management strategies in a more efficient and cost-effective way. Real estate derivatives also enable investors to execute strategies such as hedging and short-selling, strategies that they would otherwise be unable to execute in this asset class. Our examples illustrate that real estate derivatives could be *the* tool for efficient asset allocation and risk management that the industry has struggled to provide.

Despite all their potentials, real estate derivatives have yet to be well recognized and widely used as compared to its counterparts in the equity and fixed income markets. Through our survey of U.S. investors and study on real estate derivatives in the UK, we identified three major issues that need to be addressed to establish a successful real estate derivative market: liquidity, index, and pricing. We argue that liquidity can only be created and enhanced by strong leadership and initiative by reputable market participants. This has clearly made a difference in the UK where the market has seen healthy increase in interest and volume. On the topic of the real estate index, we show that the NCREIF Property Index is a sound index in terms of the property universe it covers, reporting standards and data accuracy, but it is fairly predictable due to its lagging nature. The MIT/CRE Transaction Based Index could be a good alternative for real estate derivatives to be based on if investors are interested in an index that tracks more closely the underlying property market. When it comes to pricing, we find that the pricing in the market seems to be converging to what our theoretical pricing methods indicate. While arbitrage pricing may not be totally applicable due to its strong assumptions, equilibrium pricing should still allow us to suitably price real estate derivatives.

While conducting our study on real estate derivatives, we have become increasingly confident of the future of real estate derivatives. As the benefits of using real estate derivatives are more widely recognized, we believe that the number of market participants will significantly increase, paving the way for the successful development of the real estate derivatives market, and enhancing the status of real estate as a major institutional asset class.

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Appendix

I. U.S. Investor Survey Result

MIT CENTER FOR REAL ESTATE

Investors Survey on Real Estate Derivatives

Section 3. Survey Questions - Part 1

This section is to help us understand your general needs and concerns on real estate derivatives

2. What type of organization do you work for?

	Number of Responses	Response Ratio
Investment manager	16	43%
Pension fund	2	5%
Hedge fund	0	0%
Endowment fund	1	3%
REIT	0	0%
Commercial lender	5	14%
Insurance company	0	0%
Private investor or family office	1	3%
VIEW Other, Please Specify	12	32%

3. Prior to this survey, were you aware of real estate derivatives?

	Number of Responses	Response Ratio
Yes	36	97%

No	1	3%
Total	37	100%

4. What do you think the most attractive benefit of using real estate derivatives will be relative to direct property investment or REITs? Please rate the importance of the following benefits.

The top percentage indicates total respondent ratio; the bottom number represents actual number of respondents selecting the option	1 Very Important	2 Important	3 Somewhat Important	4 Not Important
1. Taking short position on real estate	44% 16	28% 10	28% 10	0% 0
2. Easy target asset allocation	41% 15	38% 14	16% 6	5% 2
3. Diversified underlying asset (avoid specific or basis risk)	19% 7	56% 20	22% 8	3% 1
4. Limited upfront cost	14% 5	47% 17	33% 12	6% 2
5. Quick execution	33% 12	36% 13	31% 11	0% 0

5. What are the other benefits you perceive in real estate derivatives, if any?

VIEW 18 Responses

6. What would be the major concerns you would have in investing in real estate derivatives? Please rate the importance of the following issues.

The top percentage indicates total respondent ratio; the bottom number represents actual number of respondents selecting the option	1 Very Important	2 Important	3 Somewhat Important	4 Not Important
1. Not sure how to price real estate derivatives	39% 14	33% 12	19% 7	8% 3
2. Difficulty in explaining real estate derivatives to CIO, investors, or trustees	9% 3	38% 13	32% 11	21% 7
3. Liquidity	44% 15	44% 15	9% 3	3% 1
4. Lack of secondary market for real estate derivatives	51% 18	31% 11	11% 4	6% 2
5. Passive investment or no Alpha	3% 1	23% 7	42% 13	32% 10
6. Lack of expertise in derivatives	21% 7	18% 6	24% 8	38% 13
7. Lack of expertise in real estate	0% 0	3% 1	24% 8	73% 24
8. Difficulty in mark-to-market valuation of real estate derivatives	11% 4	51% 18	31% 11	6% 2
9. Lack of dealers in real estate derivatives marketplace	29% 10	43% 15	20% 7	9% 3
10. Not putting money to work(derivatives				

are notional based with a limited upfront cash outlay)	11% 4	14% 5	31% 11	43% 15
11. Settlement or counterparty risk	11% 4	37% 13	26% 9	26% 9
12. Index based on appraisal	23% 8	11% 4	43% 15	23% 8
13. Insufficient coverage of NCREIF property database	17% 6	29% 10	37% 13	17% 6
14. Frequency of Index updating	14% 5	25% 9	42% 15	19% 7
15. Internal restriction on use of derivatives	3% 1	15% 5	33% 11	48% 16
16. External restriction on use of derivatives	3% 1	24% 8	33% 11	39% 13

7. Please describe other concern(s) you would have in investing in real estate derivatives, if any.

VIEW 9 Responses

8. If you were to begin using real estate derivatives, what would be your main purpose(s)? Please check all that apply.

	Number of Responses	Response Ratio
Hedging your real estate market exposure	22	67%
Achieve target overall real estate allocation	13	39%
Achieve target sector balance among property types	20	61%
Speculate on real estate market movement	8	24%
VIEW Other, please specify	3	9%

9. If a training course on NCREIF property derivatives is provided, which area will you be most interested in? Please rate the importance of following topics.

The top percentage indicates total respondent ratio; the bottom number represents actual number of respondents selecting the option	1 Very Important	2 Important	3 Somewhat Important	4 Not Important
1. How to price real estate index derivatives	53% 19	36% 13	8% 3	3% 1
2. How to mark real estate index derivatives to market	31% 11	40% 14	20% 7	9% 3
3. Basic information on NCREIF NPI index	6% 2	10% 3	26% 8	58% 18
4. Terms & conditions of derivatives contract	29% 10	32% 11	32% 11	6% 2

10. What additional topics, if any, would you like to be covered in the training course?

VIEW 8 Responses

Section 4. Survey Questions - Part 2

This section is to help us understand the potential market for real estate derivatives

11. How would you characterize the asset allocation of your organization with regard to private real estate (excluding REITs)?

	Number of Responses	Response Ratio
Predominantly in real estate	19	51%
Mixed asset with allocation in real estate	13	35%
Mixed asset with no allocation but interest in real estate	2	5%
Mixed asset with no allocation and no interest in real estate	3	8%
Total	37	100%

12. With regard to the typical or major fund or portfolio that your organization manages, what is the approximate real estate allocation in percentage of overall fund or portfolio?

	Number of Responses	Response Ratio
Greater than 0% and less than 5%	3	13%
Greater than 5% and less than 10%	9	39%
Greater than 10% and less than 15%	1	4%
Greater than 15% and less than 50%	1	4%
Greater than 50%	9	39%

13. Within the real estate part of that fund or portfolio, which property type sectors do you focus on primarily? Please check all that apply.

	Number of Responses	Response Ratio
Office	26	100%
Multifamily	24	92%
Retail	25	96%
Industrial	25	96%
Hotel	17	65%
VIEW Other, Please Specify	10	38%

14. What are your investment styles in real estate? Please check all that apply.

	Number of Responses	Response Ratio
Core: stabilized properties, low or		

no debt, relatively passive management	25	93%
Value-added: more debt, turnaround, higher risk & return compared to core	22	81%
Opportunistic: more debt, development, broader vehicles, active management	16	59%
Don't know/not sure	1	4%

15. Does your organization intend to change its current real estate allocation level? Please check all that apply.

	Number of Responses	Response Ratio
Yes - real estate allocation in overall portfolio	6	26%
Yes - property sector allocation in real estate portfolio	9	39%
Yes - allocation in different investment styles	4	17%
No - maintain the current level	12	52%

16. What type of real estate derivatives would you be interested in? Please check all that apply.

	Number of Responses	Response Ratio
NPI Capital Value Return Swap	6	19%
NPI Total Return Swap	8	26%
NPI Property Type Swap	11	35%
Options (puts, calls, and other exotic options)	7	23%
All of the above	21	68%
None of the above	0	0%

17. Do you think that it is important to have real estate derivatives based on geographic regional indices?

	Number of Responses	Response Ratio
Very Important	13	39%
Important	11	33%
Somewhat Important	7	21%
Not Important	2	6%
Total	33	100%

18. Which maturity of real estate derivatives do you think will be most useful?

	Number of Responses	Response Ratio
6 month ~ 1 Year	7	22%
1 Year ~ 3 Year	13	41%

3 Year ~ 5 Year	6	19%
5 Year ~	6	19%
Total	32	100%

19. How do you feel about the prospect of real estate derivatives in the U.S.?

	Number of Responses	Response Ratio
Very optimistic (It will take off within 2 years)	7	21%
Optimistic (It will take off in 3-5 years)	18	55%
Cautiously Optimistic (It will take longer than 5 years)	8	24%
Pessimistic (it has no future)	0	0%
Not sure	0	0%
Total	33	100%

II. The NPI Forecasting: Data and Forecast Results

The NPI Capital Return Forecast

NPI Capital Return Data 1978-2005

YEAR	NPI	TBI	NAREIT	NPIYLDSPRD
1978	6.81%	13.83%	2.66%	-1.47%
1979	10.80%	16.87%	25.49%	-2.49%
1980	9.11%	8.66%	1.95%	-4.52%
1981	8.08%	15.80%	-2.03%	-7.82%
1982	1.46%	-7.66%	11.49%	-5.24%
1983	4.94%	7.91%	21.01%	-5.84%
1984	5.89%	8.48%	9.30%	-5.85%
1985	3.51%	10.68%	9.62%	-3.39%
1986	0.89%	-0.67%	10.56%	-2.89%
1987	0.69%	-6.00%	-10.31%	-4.05%
1988	2.46%	-0.57%	4.77%	-4.43%
1989	1.06%	-3.87%	0.58%	-3.61%
1990	-4.10%	1.14%	-26.46%	-3.59%
1991	-11.77%	-9.72%	25.47%	-2.17%
1992	-11.19%	-9.94%	6.40%	-1.43%
1993	-6.43%	9.10%	12.95%	-0.22%
1994	-2.22%	0.57%	-3.52%	-1.60%
1995	-1.49%	3.94%	6.56%	1.23%
1996	1.34%	6.05%	26.35%	0.41%
1997	4.51%	15.37%	13.33%	1.57%
1998	7.00%	6.76%	-22.33%	1.59%
1999	2.80%	-0.60%	-12.21%	0.11%
2000	3.44%	2.58%	16.51%	0.95%
2001	-1.28%	-0.30%	5.85%	1.27%
2002	-1.59%	4.32%	-3.12%	2.00%
2003	1.17%	4.19%	28.48%	0.68%
2004	6.79%	10.67%	24.35%	0.36%
2005	12.78%	29.36%	6.68%	-0.12%

NPI: NCREIF Property Index

TBI: MIT/CRE Transaction Based Index

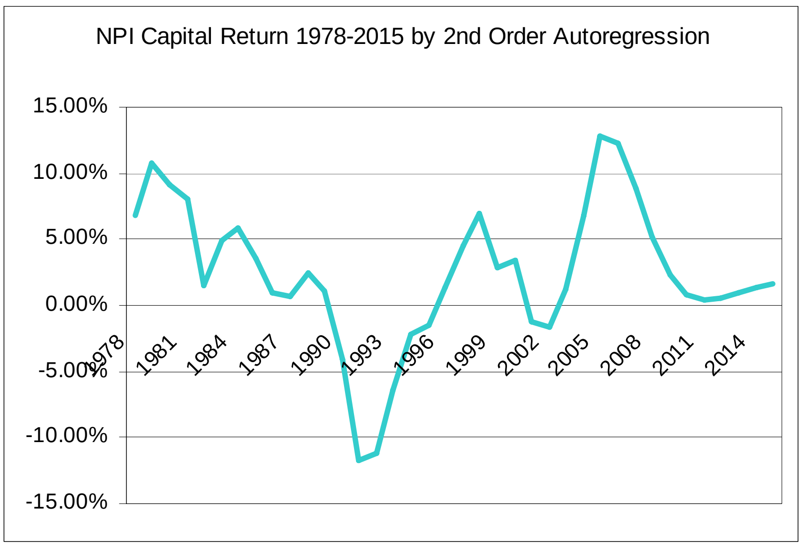
NAREIT: REIT Index

NPIYLDSPRD: Spread of NPI Return over Ten-year Treasury

Simple 2nd Order Autoregression

Statistical Output of Simple 2rd Order Autoregression on NPI Capital Return
Sample (adjusted): 1980 2005
Included observations: 26 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
NPI $_{t-1}$	1.1732	0.1936	6.0591	0.0000
NPI $_{t-2}$	-0.4699	0.1936	-2.4273	0.0235
C	0.0049	0.0067	0.7249	0.4758
R-squared	0.6907	Mean dependent var		0.0146
Adjusted R-squared	0.6638	S.D. dependent var		0.0569
S.E. of regression	0.0330	F-statistic		25.6752
Sum squared resid	0.0251	Prob(F-statistic)		0.0000



NPI Capital Return Forecast
Year 2006-2015

Year	NPI
2006	12.29%
2007	8.90%
2008	5.15%
2009	2.35%
2010	0.82%
2011	0.34%
2012	0.50%
2013	0.92%
2014	1.32%
2015	1.61%

Four Variable Vector Autoregression

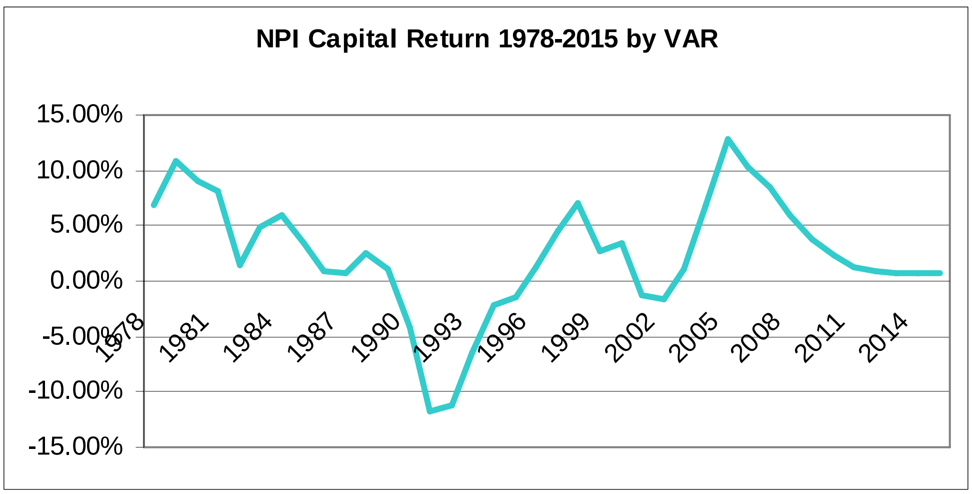
Statistical Output of Vector Autoregression on NPI Capital Return
Sample (adjusted): 1980 2005
Included observations: 26 after adjustments

	NPI	TBI	NAREIT	NPIYLDSPRD
NPI $_{t-1}$	1.1274	0.9778	-1.1089	-0.1075
	0.2889	0.5943	1.5790	0.1535
	[3.90284]	[1.64544]	[-0.70228]	[-0.70032]
NPI $_{t-2}$	-0.3026	-0.2225	0.3492	-0.0190
	0.2666	0.5484	1.4572	0.1417
	[-1.13527]	[-0.40564]	[0.23965]	[-0.13430]
TBI $_{t-1}$	-0.1816	-0.4668	0.3738	0.0288
	0.1243	0.2558	0.6796	0.0661
	[-1.46059]	[-1.82524]	[0.54999]	[0.43535]
TBI $_{t-2}$	0.0722	-0.0212	-0.0102	-0.0079
	0.1128	0.2321	0.6167	0.0600
	[0.63972]	[-0.09140]	[-0.01660]	[-0.13143]
NAREIT $_{t-1}$	0.1257	0.2874	0.0105	-0.0087
	0.0441	0.0908	0.2412	0.0234
	[2.84892]	[3.16645]	[0.04364]	[-0.37258]
NAREIT $_{t-2}$	0.0629	0.3255	-0.2787	-0.0099
	0.0486	0.1000	0.2657	0.0258
	[1.29511]	[3.25519]	[-1.04896]	[-0.38362]
NPIYLDSPRD $_{t-1}$	0.2285	0.3454	-1.1520	0.6113
	0.4677	0.9622	2.5566	0.2486
	[0.48846]	[0.35894]	[-0.45060]	[2.45916]
NPIYLDSPRD $_{t-2}$	0.1437	0.6313	1.0280	0.2356
	0.4804	0.9884	2.6263	0.2554
	[0.29912]	[0.63871]	[0.39142]	[0.92275]
C	0.0015	0.0270	0.0745	0.0004
	0.0091	0.0187	0.0497	0.0048
	[0.16970]	[1.44195]	[1.50003]	[0.08443]
R-squared	0.8272	0.6850	0.1443	0.8012
Adj. R-squared	0.7459	0.5368	-0.2585	0.7076
Sum sq. resids	0.0140	0.0592	0.4182	0.0040
S.E. equation	0.0287	0.0590	0.1568	0.0152
F-statistic	10.1749	4.6216	0.3582	8.5617
Log likelihood	60.9615	42.2059	16.7976	77.3956
Akaike AIC	-3.9970	-2.5543	-0.5998	-5.2612
Schwarz SC	-3.5615	-2.1188	-0.1643	-4.8257
Mean dependent	0.0146	0.0409	0.0624	-0.0179
S.D. dependent	0.0569	0.0867	0.1398	0.0282

Dependant variables are listed horizontally
Independent variables are listed vertically
For each dependant variable, first line is coefficient, second line standard error, third line t statistics

NPI Total Capital Return Forecast
Year 2006-2015

Year	NPI	TBI	NAREIT	NPIYLDSPRD
2006	10.34%	9.78%	0.31%	-0.99%
2007	8.50%	6.62%	2.96%	-1.97%
2008	5.91%	5.06%	5.20%	-2.42%
2009	3.81%	4.46%	5.68%	-2.68%
2010	2.29%	3.78%	6.12%	-2.71%
2011	1.35%	3.21%	6.44%	-2.60%
2012	0.88%	3.16%	6.50%	-2.43%
2013	0.69%	3.20%	6.49%	-2.23%
2014	0.68%	3.29%	6.49%	-2.04%
2015	0.78%	3.47%	6.45%	-1.87%



The NPI Total Return Forecast

NPI Total Return Data 1978-2005

YEAR	NPI	TBI	NAREIT	NPIYLDSPRD
1978	16.11%	21.01%	-1.64%	-1.47%
1979	20.46%	24.30%	30.53%	-2.49%
1980	18.07%	15.56%	28.02%	-4.52%
1981	16.63%	20.96%	8.58%	-7.82%
1982	9.44%	-2.49%	31.64%	-5.24%
1983	13.12%	14.19%	25.47%	-5.84%
1984	13.83%	14.34%	14.82%	-5.85%
1985	11.23%	17.37%	5.92%	-3.39%
1986	8.30%	4.61%	19.18%	-2.89%
1987	8.00%	-1.49%	-10.67%	-4.05%
1988	9.63%	4.63%	11.36%	-4.43%
1989	7.76%	0.69%	-1.81%	-3.61%
1990	2.29%	6.52%	-17.35%	-3.59%
1991	-5.59%	-4.41%	35.68%	-2.17%
1992	-4.26%	-4.02%	12.18%	-1.43%
1993	1.39%	15.97%	18.55%	-0.22%
1994	6.38%	7.02%	0.81%	-1.60%
1995	7.53%	11.12%	18.31%	1.23%
1996	10.30%	13.49%	35.75%	0.41%
1997	13.90%	23.28%	18.86%	1.57%
1998	16.24%	13.46%	-18.82%	1.59%
1999	11.37%	5.77%	-6.48%	0.11%
2000	12.31%	9.01%	25.89%	0.95%
2001	7.35%	6.42%	15.50%	1.27%
2002	6.80%	14.60%	5.22%	2.00%
2003	9.20%	7.35%	38.47%	0.68%
2004	14.61%	16.19%	30.41%	0.36%
2005	20.16%	34.16%	8.29%	-0.12%

NPI: NCREIF Property Index

TBI: MIT/CRE Transaction Based Index

NAREIT: REIT Index

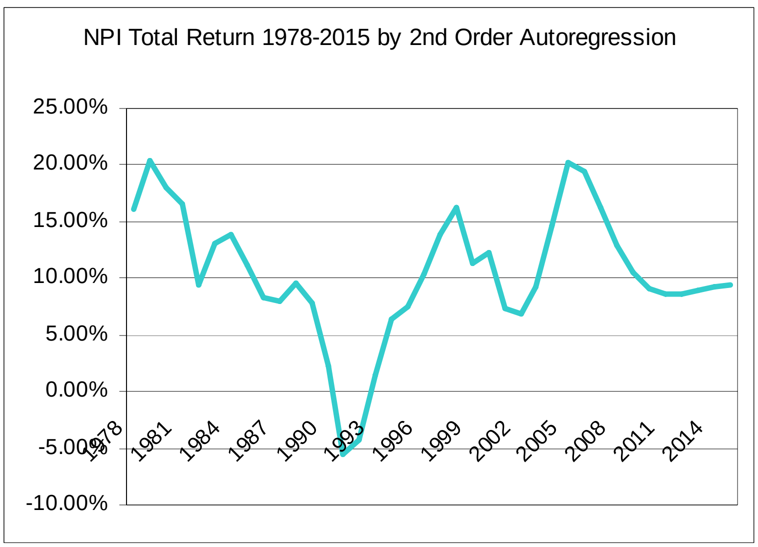
NPIYLDSPRD: Spread of NPI Return over Ten-year Treasury

Simple 2nd Order Autoregression

Statistical Output of Simple 2rd Order Autoregression on NPI Total Return
Sample (adjusted): 1980 2005
Included observations: 26 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
NPI $_{t-1}$	1.1462	0.1909	6.0031	0.0000
NPI $_{t-2}$	-0.4368	0.1892	-2.3089	0.0303
C	0.0277	0.0132	2.0896	0.0479

R-squared	0.7009	Mean dependent var	0.0946
Adjusted R-squared	0.6749	S.D. dependent var	0.0614
S.E. of regression	0.0350	Akaike info criterion	-3.7578
Sum squared resid	0.0282	Schwarz criterion	-3.6126
Log likelihood	51.8510	F-statistic	26.9438
Durbin-Watson stat	1.9184	Prob(F-statistic)	0.0000



NPI Total Return Forecast
Year 2006-2015

Year	NPI
2006	19.49%
2007	16.30%
2008	12.94%
2009	10.47%
2010	9.12%
2011	8.65%
2012	8.69%
2013	8.95%
2014	9.23%
2015	9.44%

Four Variable Vector Autoregression

Statistical Output of Vector Autoregression on NPI Total Return
Sample (adjusted): 1980 2005
Included observations: 26 after adjustments

	NPI	TBI	NAREIT	NPIYLDSPRD
NPI $_{t-1}$	1.1445	1.1193	-1.8674	-0.0969
	0.2508	0.5209	1.5437	0.1328
	[4.56405]	[2.14880]	[-1.20976]	[-0.72993]
NPI $_{t-2}$	-0.3437	-0.3640	1.0081	-0.0086
	0.2194	0.4558	1.3507	0.1162
	[-1.56640]	[-0.79867]	[0.74631]	[-0.07373]
TBI $_{t-1}$	-0.1672	-0.4510	0.7963	0.0182
	0.1140	0.2368	0.7017	0.0604
	[-1.46671]	[-1.90508]	[1.13486]	[0.30105]
TBI $_{t-2}$	0.0572	-0.0649	-0.0221	-0.0070
	0.1028	0.2135	0.6326	0.0544
	[0.55705]	[-0.30409]	[-0.03495]	[-0.12781]
NAREIT $_{t-1}$	0.1136	0.2453	0.1059	-0.0144
	0.0365	0.0757	0.2245	0.0193
	[3.11560]	[3.23812]	[0.47177]	[-0.74383]
NAREIT $_{t-2}$	0.0622	0.2727	-0.2451	0.0014
	0.0400	0.0830	0.2461	0.0212
	[1.55625]	[3.28360]	[-0.99591]	[0.06827]
NPIYLDSPRD $_{t-1}$	0.4536	1.1389	-2.9723	0.6301
	0.4599	0.9553	2.8312	0.2435
	[0.98638]	[1.19218]	[-1.04983]	[2.58711]
NPIYLDSPRD $_{t-2}$	-0.0229	0.0194	3.0098	0.2416
	0.4663	0.9687	2.8708	0.2469
	[-0.04904]	[0.02001]	[1.04842]	[0.97836]
C	0.0130	0.0312	0.1611	0.0095
	0.0133	0.0277	0.0821	0.0071
	[0.97808]	[1.12675]	[1.96129]	[1.33882]
R-squared	0.8519	0.7015	0.1742	0.8031
Adj. R-squared	0.7822	0.5610	-0.2144	0.7104
Sum sq. resids	0.0140	0.0602	0.5291	0.0039
S.E. equation	0.0287	0.0595	0.1764	0.0152
F-statistic	12.2256	4.9941	0.4483	8.6661
Log likelihood	60.9922	41.9850	13.7389	77.5219
Akaike AIC	-3.9994	-2.5373	-0.3645	-5.2709
Schwarz SC	-3.5639	-2.1018	0.0710	-4.8354
Mean dependent	0.0946	0.1016	0.1361	-0.0179
S.D. dependent	0.0614	0.0898	0.1601	0.0282
Determinant resid covariance (dof adj.)		0.0000		
Determinant resid covariance		0.0000		
Log likelihood		200.1036		
Akaike information criterion		-12.6234		
Schwarz criterion		-10.8814		

Dependant variables are listed horizontally
Independent variables are listed vertically
For each dependant variable, first line is coefficient, second line standard error, third line t statistics

NPI Total Return Forecast
Year 2006-2015

Year	NPI	TBI	NAREIT	NPIYLDSPRD
2006	17.34%	14.10%	14.89%	-0.69%
2007	15.72%	11.74%	15.75%	-1.56%
2008	14.20%	14.33%	13.84%	-1.96%
2009	12.13%	11.50%	15.34%	-2.18%
2010	10.87%	10.43%	15.40%	-2.29%
2011	10.20%	10.73%	14.22%	-2.27%
2012	9.65%	10.13%	13.91%	-2.18%
2013	9.29%	9.71%	13.84%	-2.07%
2014	9.13%	9.76%	13.64%	-1.94%
2015	9.06%	9.79%	13.58%	-1.80%