MASTER

The effect of selling property derivatives on the risk and return of the investment portfolio
a calculation model for the risk and return of an investment portfolio with property derivatives

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The effect of selling property derivatives on the risk and return of the investment portfolio.

A calculation model for the risk and return of an investment portfolio with property derivatives
Master thesis
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“Derivatives are financial weapons of mass destruction”
(Warren Buffet, 2003)
Preface

This is the result of 12 months of orientation, discovering, learning and writing on the subject of property derivatives. It is the finishing touch on 7 years of academically education and I hope it represents the things I've learned. I'm more than eager to expand my view and start my professional career in order to develop myself in more ways.

With this report I hope to have helped Protego explaining what property derivatives can do for investors, at the same time I hope that this quantitative approach, the first in it's kind, will help develop the transparency and liquidity of the property derivatives market.

At last I would like to thank my supervisors, Kees Kokke, Robert Weisz and Peter de Haas, for their support. It helped me to focus on the things that were truly important. Especially the unique possibility to meet important property derivatives participants, provided by Peter de Haas, helped the study to become practically relevant. Many thanks for that.

At last I would like to thank the people who supported me at home during my graduation period and during my whole study, especially Kim for helping me for so long.

I hope you enjoy reading the report and for any inquiries please contact me.

Huib Vaessen
Huibvaessen@hotmail.com

Den Haag, November 2006
Summary

A property derivative is a financial instrument that is based on the return of property. An example is a property investment certificate (PIC) where the buyer pays capital upfront and receives over the maturity of the PIC the returns of the IPD index over the capital paid. The IPD index represents all property in a market.

The use of these property derivatives is booming, especially in the UK, where already over one billion1 of property derivatives have been traded in 2005 (IPD, 2006). These property derivatives are solely property swaps and PIC’s. A property swap is an agreement where the buying party swaps a LIBOR interest rate for the IPD return over a certain notional amount for the maturity of the swap.

Possible advantages of the use of property swaps and PIC’s are that the buyer does not have to pay the high transaction costs as with direct property and does get a diversified property portfolio. Furthermore it is possible to obtain this investment quickly, much quicker than it is possible to buy a direct property portfolio.

However although there are enough buyers, property investors are not anxious to sell a lot of property derivatives. This slows the development of the property derivatives market. A probable reason for the lack of sellers is that property investors have a lack of knowledge with respect to property derivatives; they do not know what the effect for their investments will be when selling property derivatives. This lack of knowledge is the primary reason for conducting this study. The research question follows from the problem described above and is:

“What are the implications of selling property derivatives for the risk and return of the seller of risk’s investment portfolio?”

The goal of this study is:

“To get insight into the implications of selling property derivatives on the risk and return of the portfolio of the seller in order to support them making their decision, increase transparency and increase liquidity and the development of the market.”

The study investigates the relation between selling property derivatives and the risk and return of the investment portfolio. The investment portfolio consists of property derivatives and a direct property portfolio. The relation is visualized below.

This risk and return are influenced by selling more property derivatives because of the sellers’ liabilities of paying IPD index returns. This relation is investigated by the development of a calculation model that calculates the difference in risk and return of the investment portfolio when more property derivatives

---

1 The 1 billion estimate of IPD can be too high since two counterparties of a single trade report the trade independently so that one trade can be counted twice in the estimate.
are sold. The study is explorative, on beforehand no proposition is made about the relation; there is no hypothesis to test. The model is tested on the correctness of the calculations and the sensitivity of the input parameters. Finally in a real life case and two hypothetical cases is shown how the model is used.

**Calculation of risk**
The risk is characterized by the probability of underperformance and the standard deviation of the investment portfolio. The probability of underperformance is calculated by a statistical procedure with the standard deviation and the expected return, the expected return is modelled by the return model. By reviewing the literature and interviewing property professionals it appeared that the standard deviation of the investment portfolio can be broken down into several components they are shown below in the figure.

![Diagram of risk calculation](image)

**Formula:**
The standard deviation of the investment portfolio containing property derivatives.

\[
X_{std} = \sqrt{(x_m^2 + x_{pd}^2 + 2x_m x_{pd})\sigma_m^2 + x_m^2 (\beta - 1)^2 + (Q/n)^2}
\]

**Calculation of return**
The return is calculated by calculating the Modified Internal Rate of Return over the net cash flows of the investment portfolio over the maturity of the property derivative. The model automatically calculates the cash flows according to several input parameters. The input parameters are recognized by the literature and by interviews with property professionals.
Sensitivity and Correctness

The model was checked by Prof. dr. ir. Van Berkum in statistics whether the calculations made were correct. They approved the calculations. A sensitivity check was performed whether the output of the model was not dependent on one single parameter. This was done by determining standards for the values of all the input parameters, then the values of one single input parameter were altered from the minimum to the maximum. The effect of the change of one single parameter on the relation between selling property derivatives and the risk and return of the investment portfolio was measured. The results of these sensitivity tests are that the most important input parameters are the premium of the property derivatives, the excess beta performance and the Beta of the direct property portfolio. The sensitivity tests also showed that there is no single input parameter that determines more than 60% of the output. This means that the sensitivity is well spread over the input parameters.

Real life case

Three cases show the results of the use of the model, one of these cases is briefly described below. Investor X wants to buy a direct property portfolio, however he has insufficient capital. Therefore he wants to sell PIC's so that he gains cash upfront and can buy the property portfolio. Investor X wants to know what the effect is of selling PIC's on the risk and return of the investment portfolio. The investment portfolio contains direct property and the liabilities of the sold PIC's and it is expected that the property portfolio will outperform the market.

The results obtained by the model are shown below.

The graphs above show that the standard deviation and the return of the investment portfolio increase when more property derivatives are sold. The risk decreases until about 75% of the direct property portfolio is sold as property derivatives, after that the risk increases rapidly.
Important to notice is that the more PIC’s are sold, the more sensitive the investment portfolio becomes to out and underperformance of the direct property portfolio. This is shown in the graph above. The graph on the right shows the effect of selling more property derivatives on the ratio return/risk for various property derivatives premiums, here a higher ratio means a better risk/return trade off.

Conclusion and recommendations

The research question is answered and the goal of the study is met. With this study and calculation model property investors can see the effect of selling property derivatives on the risk and return of their investment portfolio. It quantifies what the experts know about the effect of property derivatives. The relation between selling property derivatives and the risk and return of the investment portfolio depends on the values of 19 different input parameters. In a standard situation the return and the standard deviation increase when selling PIC’s and decrease when swapping the IPD return for an interest rate. Another main result is that when selling more property derivatives the investment portfolio becomes more sensitive to the out and underperformance of the direct property portfolio. This study showed quantitatively that PIC’s can be used for taking up more risk and a higher return while swaps can be used to create a low risk/low return investment.

The unique quantitative approach to estimating the risk and return of a portfolio with property derivatives opens up a lot of areas for further research.

- The model can be expanded by taking into account more different kinds of property derivatives, in this model only the most used property derivatives in 2006 are taken into account.
- The model can be expanded by taking into account more different investment portfolios. For example the effect of property derivatives on an investment portfolio with indirect property can be modelled.
- The input parameters can be studied further:
  - The premium of property derivatives is in this report an input parameter, this premium can be decomposed in several components.
  - The Beta of the direct property portfolio can be modelled in further research.
  - The level of diversification can be estimated more accurately with further research, it is in this report determined by the number of assets in a portfolio.
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Section A: Chapter one: Introduction

§ 1.1 Introduction
A property derivative is a financial instrument that is based on the return of property. These financial instruments can take any shape, but the property derivatives that are most widely used are so called property index certificates and property total return swaps. For example, a property index certificate (PIC) is a financial instrument where the buyer pays capital upfront and receives over the maturity of the PIC the returns of the IPD index\(^2\) over the capital paid.

Over 2005, the use of property derivatives has seen enormous growth in especially the United Kingdom. There was always some turnover of property derivatives since the mid 1990’s, but the market remained illiquid and one-sided. Turnover of property derivatives has struggled around 200 million pounds until in 2005 the one billion has reached (IPD, 2006). This is a major breakthrough with a turnover increase of 500%.

More important than the past growth is the potential future growth which is a lot harder to measure. Experts’ views differ on the potential size of the market but agree that it must be huge. Estimates of potential sizes range from 10 billion in two to three years time to 30 billion in the UK alone (Reuters, 2006). The 30 billion is based upon 20% of the underlying property deals. Besides growth in size the property derivatives market is also growing in diversity. New property derivatives are being developed like swaps on property submarkets and on property markets outside the UK.

The potential of the market is justified by the favourable characteristics of the property derivatives compared with direct or indirect investment in property. Examples of advantages of buying property derivatives over direct or indirect property are the saving of transaction costs, the possibility to buy a perfectly diversified portfolio and increased liquidity of the investment. Advantages of selling derivatives are that high premiums are being paid for them and almost no transaction costs are involved. However, although agreed is on an enormous potential for the market and favourable characteristics of these property derivatives, the market remains till today illiquid.

There are many more participants willing to buy than to sell as is shown by a survey of Boeve (2002). He surveyed potential buyers of property derivatives and concluded that there was a clear need of property derivatives. While on the other hand he showed that there was a lack of sellers because of the unfamiliarity of them with the concept. With the increased attention for the market the balance of buyers and sellers gets distorted more and more.

The increasing prices of the most traded property derivatives, the property index certificates, also show the shifting balance. Premiums on comparable property index certificates, which are till now the most traded instruments, have surged over 2005 with more than 100% (Barclays, April 2005, July 2006).

This illiquidity hampers the development of the market and decreases the potential of the property derivatives since one of the main advantages of the instruments can be the higher liquidity over direct and indirect property. Since the decreased attractiveness of the derivative causes a decrease in liquidity this is a downward sloping loop.

While there is a lot of potential the illiquidity hampers the development of a large and diversified property derivatives market. The main reason for this unnecessary illiquidity is the market participants lack of knowledge on property derivatives. Especially the property companies, who are in the best position to sell property derivatives, bear any understanding of the concept. Boeve (2002) argued that the reason

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\(^2\) IPD index: The IPD index represents the aggregate returns for a whole property market.
for the lack of understanding can be the non-financial background of many employees at the property companies.

While there is enough interest in the subject, there are a lot of uncertainties on the benefits and risks involved when selling such a new financial product. This effect is worsened by the loose term property derivatives, which can have many different meanings.

The boom in property derivatives, the enormous interest from market participants for it and the lack of knowledge on the concept on mainly the sell side which causes illiquidity were the reasons for the initiation of this study.

§ 1.2 Goal
The goal of this study is a logical consequence of the issue described in the introduction and forms the focus of the research question which will be formulated next.

The goal of this study is

"To get insight into the implications of selling property derivatives on the risk and return of the portfolio of the seller in order to support them making their decision, increase the transparency, liquidity and the development of the market."

For the seller, also called the seller of risk, his interest will be the performance of his investment portfolio, the performance of this portfolio is characterised by the return of that portfolio and the risk involved getting that return(Van Gool, Jager, Weisz, 2001). This is the reason why this study will focus on the implications on the risk and return of the sellers' investment portfolio.

When satisfying the goal this study will have added knowledge to the existing academical literature by showing the effect of selling property derivatives on the risk and return of the investment portfolio, this is the academic relevance.

Thereby, on the short term, it will be practically relevant for property companies facing the decision whether to sell property derivatives or not. The relevance on the long term of the study is that it can contribute to the increasing transparency, liquidity and development of the property derivatives market.

§ 1.3 Research question
The research question is the actual query that has to be solved in order to satisfy the goal. That's why it has a close relation with the goal and is actually a reframing of it.

The research question is:

"What are the implications of selling property derivatives for the risk and return of the seller of risk's investment portfolio?"

The study is an explorative study, which investigates the relationship between adding property derivatives to an investment portfolio and the risk and return of that investment portfolio. This is visualized in the scheme below.
The study does not take a position whether the risk and return will be increased or decreased, there is no hypothesis to test.

The why: supporting property companies making a decision on selling, and increasing liquidity and development of the market, and what we want to know; the implications of selling property derivatives for the risk and return on the investment portfolio, of this study are formulated above now. Below is defined the how of this study by defining the subquestions.

§ 1.4 Sub-questions
Since there is no empirical evidence on the relationship, the implications of selling property derivatives on the risk and return have to be modeled. The research question is divided into sub-questions, which add up to the research question, in order to make the question more comprehensible. These will be answered through out the study and these answers will provide a valid answer to the main research question.

The sub questions will be discussed briefly below, each sub question is divided into more questions.

1. How to model risk?
   a. How to express the volatility and risk of the investment portfolio?
   b. Which elements do contribute to the volatility and risk?
   c. What is the (quantitative) relation between these elements and the volatility and risk?
   d. Which elements to use as input parameters for the model?

2. How to model return?
   a. How to express the return of the investment portfolio?
   b. Which elements do contribute to the return?
   c. What is the (quantitative) relation between these elements and the return?
   d. Which elements to use as input parameters for the model?

3. How to test the contribution of each element to the studied relationship?
   a. Which input parameters do have the most impact on the output of the model.

4. How does the model work in practice, what are the results?

When all these questions are answered it is possible to model the effect of selling property derivatives on the risk and return of the seller's portfolio and the research question is answered.

The research methods that will be used in order to answer all these questions will be discussed below in the structure and organisation of the study.
§ 1.5 Structure and organisation

The study will be conducted in the following way:

1. First will be determined what the definitions are for the risk, return, investment portfolio, property derivatives and seller of risk.

2. Then the two models for risk and return will be set up. Therefore the elements that determine the risk and return have to be identified and the relation between the elements and the risk and return. The literature is reviewed for this and property professionals are interviewed. Only when all the important elements are known and when the relation between the elements and the output is quantifiable, only then, the elements can be taken into account in the model.

3. The risk and return model are tested on the influence each input parameter has on the outcome of the model. There will be zoomed in on the parameter in order to break it down into more parameters if this influence is too large, this is done by reviewing the literature and interviewing experts. In this way the power of the model increases. This process is shown in the figure below.

4. When the models are optimized they will be used in a real life case and a hypothetical case. This will show the relationship between adding property derivatives and the risk and return of an investment portfolio.

![Figure two: Set up of the model]

§ 1.6 Outlining

The approach described above results in a report with the following outlining. The study is divided into four sections, A,B, C and D.

Section A is the set-up of the study, the following questions are answered:

- Why do we study this research question, what is it relevance?
- What do we study?
- How do we find an answer on the research question?

Section B contains the set up of the models for the risk and return of the investment portfolio which are used to show the effect of selling property derivatives. In order to set up each model it is necessary to
know how to measure risk or return, what elements do influence it and how do these elements influence the risk or return.

Section C is the test section. It contains a test, one test will check how much each parameter of the model influences the studied relationship. When a certain parameter has too much influence on the relation the risk of garbage in and garbage out becomes larger. To decrease the influence of a single parameter the study will then zoom in on that parameter to find it's determinants.

Section D shows the relationship by means of a real life and a hypothetical case. It also contains the conclusions.

Figure three on the next page shows the set up of the study, the chapters, sections, sub research questions and data collection methods are mentioned.
Figure three
Set up of the study

- Literature
  Section A

- Literature
  Section B

- Calculations
  Section C

- Empirical data
  Section D
§ 1.7 Scope
The scope sets the boundaries for the research. The why, what and how of this study have been discussed. Important is to pay some attention to the aspects that will not be covered in this study.

There are several boundaries:

- The level of aggregation of the study is restricted.
- Only the effect of selling property index certificates and swaps are studied.
- Only the effect of these property derivatives on an investment portfolio consisting of direct property is studied. Other investment portfolio’s are not taken into account.
- No fiscal aspect will be examined. Only the risk and return of the investment portfolio. See Kruissen(2003) for a closer look at the fiscal aspects.

In the following chapter the concepts used in this study will be explained and the framework for the study will be set.
Section A: Chapter two: Delineation and definitions

§ 2.1 Introduction
This chapter provides the framework for the remaining of this study. The concepts used in the research question are defined in order to provide a clear understanding what this study is going to research and what not. Thereby the scope will be set on which property derivatives, which sellers of risk, which returns and which risks this study will focus.

The research question is:

"What are the implications of selling property derivatives for the risk and return of the seller of risk's investment portfolio."

The underlined concepts will be defined and explained. This chapter will first in §2.2 define the most exotic concept of this study; property derivatives. Then in §2.3 the seller of risk will be defined and in §2.4 and §2.5 the concept of risk and return will be defined.

§ 2.2 Definition property derivatives
§ 2.2.1 Formal definition
Derivatives are “financial instruments whose value depends on the values of other, more basic, underlying variables.” (Hull, 2005, p.xx) The underlying variable can be many different things. There are derivatives on stocks, the weather, freight and interest rates. The underlying of property derivatives is, hence, property. The basic underlying variables must be related to property. The definition for a property derivative becomes than:

"Financial instruments whose value depends on the values of other, more basic, property related, underlying variables."

Related means in this context that the variable has to be somehow, directly or indirectly, generated by a property or a portfolio of properties.

With this definition a wide, seemingly unlimited, spectrum of financial instruments are property derivatives. As well call3 options on a single office building as a forward contract on an a property country index are property derivatives but their properties differ hugely. That is why it is not possible to study the effect of all kinds of property derivatives. A selection of property derivatives that are most appropriate to study will be made later on in this study.

Although many different property derivatives are possible, it is also clear that some products look like property derivatives but are not. An example is inflation products that are funded with property returns, like the inflation product sold to Bouwfonds funded by the Vendex portfolio. They are sometimes

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3 See glossary for description
reported as property derivatives but since the pay off of the derivative is linked to the inflation and not to property, this product is not regarded as property derivatives.

§ 2.2.2 Disadvantages/advantages property derivatives in general
To develop the knowledge on the use of property derivatives some advantages and disadvantages are discussed below. The type of property derivatives discussed are derivatives on an index. Like the property index certificates (PIC's).

The property index certificate is an instrument where the buyer of it pays the notional amount plus a premium upfront and in return the buyer gets the IPD total return over the notional amount for the agreed maturity. The IPD represents a certain market, like the Dutch all property market, the scheme below for shows the cash flows of a PIC:

The advantage of such a product is illustrated by the following comparison of three investment alternatives; direct, indirect and property derivatives. They are compared on the relevant aspects to provide a clear view on the advantages and disadvantages of property derivatives in table one on the next page.

Now that the advantages and disadvantages of property derivatives in general are made clear and it is possible to see the use and potential they have, this study will zoom in on the spectrum of property derivatives in order to select one or two property derivatives to sell. Those property derivatives that are most feasible now and in the near feature for further investigation will be selected, this will increase the practical value of the study and model.

Please note that any history of property derivatives will not be discussed here since it has been done extensively elsewhere. See for example Domen(2003) or McAllister and Mansfield(1998).

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4 Note that property derivatives are the same as real estate derivatives, only the term property derivatives is more widely used in the UK while real estate derivatives is more used in the United States. This study uses property derivatives.
### Table one: Overview of advantages and disadvantages of derivatives

<table>
<thead>
<tr>
<th>Selection process</th>
<th>Direct property</th>
<th>Indirect property</th>
<th>PIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intensive due diligence because of individual stock picking and location selection.</td>
<td>Due diligence due to fund picking, mainly selecting managers.</td>
<td>Almost no due diligence due to only having to select a market.</td>
<td></td>
</tr>
<tr>
<td>Transaction costs</td>
<td>High due to stamp duty, on average in the Netherlands 7% and in the UK 8% (Protego, 2006).</td>
<td>Low, buying or selling shares is much less comprehensive, however transaction costs are hidden in the fund.</td>
<td>Low, minimized.</td>
</tr>
<tr>
<td>Diversification</td>
<td>Minimal, need a large portfolio to diversify idiosyncratic risk.</td>
<td>Good, can diversify easily by investing in private funds.</td>
<td>Perfect, the return is based on the market index. Since the market is perfectly diversified, the PIC returns are as well.</td>
</tr>
<tr>
<td>Liquidity</td>
<td>Low, can take up to 6 months (IPF, 2004) for selling a property.</td>
<td>Depends whether fund is private or public. Private funds are less liquid, public funds are very liquid. Liquidity is high when selling small amounts, low when selling high amounts. Depends also on the free float of a stock.</td>
<td>Low now, but when the market develops it has the potential to become a liquid capital market. Till now few products are available and liquidity is low.</td>
</tr>
</tbody>
</table>

### § 2.2.3 Property derivatives categories

Domen (2003) and Kruijsen (2003) use the following classification for property derivatives which are theoretically possible.

<table>
<thead>
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<th>Listed</th>
<th>Non-listed</th>
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<tr>
<td>Property derivatives based on direct real estate</td>
<td>Property derivatives based on direct real estate</td>
</tr>
<tr>
<td>Property derivatives based on non listed indirect real estate</td>
<td>Property derivatives based on non listed indirect real estate</td>
</tr>
<tr>
<td>Property derivatives based on listed indirect real estate</td>
<td>Property derivatives based on listed indirect real estate</td>
</tr>
<tr>
<td>Property derivatives based on a direct real estate index</td>
<td>Property derivatives based on a direct real estate index</td>
</tr>
<tr>
<td>Property derivatives based on a non-listed indirect real estate index</td>
<td>Property derivatives based on a non-listed indirect real estate index</td>
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<tr>
<td>Property derivatives based on a listed indirect real estate index</td>
<td>Property derivatives based on a listed indirect real estate index</td>
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</tbody>
</table>
Domen(2003) distinguishes listed and non listed derivatives, listed ones are listed on an exchange while non-listed derivatives are traded over the counter. The over the counter network is "a computer and telephone linked network from dealers who do not physically meet" (Hull, 2006, pp.xx). When a derivative is listed on an exchange there is more transparency, contracts are standardized and one can trade instantly. When traded over the counter, which is the alternative for on an exchange, the contracts are negotiated with differing terms, transparency is thus low and trades occur more infrequently. Pricing information is often not available unlike on an exchange. Listed derivatives are not feasible since the market has not developed that far that standardized contracts are accepted and trading occurs so often that an exchange is justified. Especially after the London FOX\textsuperscript{5} debacle it seems that first an over the counter market has to develop before a listed market can evolve.

A distinction is made between derivatives on an index and on individual assets. Derivatives on an index are the better alternative since derivatives on individual assets have two main drawbacks:

- Adverse selection problem; this means that one of the counterparties of the deal has no incentive to fulfill his obligation to the other. For example when the total returns of two assets are swapped, one could pick it's worst performing asset for trading.
- Moral hazard problem; this problem is related to the adverse selection problem. It is the risk that because of the terms of a derivative contract one of the counterparties will adjust his behaviour towards the other in a negative way. Domen(2003) mentions the classical insurers example where an insured party takes on more risk since the consequences are born by the insurer. When returns on individual buildings are traded there is no incentive for the legal owner of the building to maintain the property.

Domen(2003) furthermore distinguished three different kind of property assets where the derivative can be based upon. These are direct property, indirect property and listed indirect property. He states that derivatives on direct property and indirect non listed real estate are preferred over derivatives on listed indirect real estate since the risk/return characteristics of listed real estate behave more like stocks and less like property, a risk/return profile that behaves like direct property is favourable because of the low correlation with other asset classes.

\textsuperscript{5} The London Fox Exchange was a property derivatives exchange initiative in 1994 which failed due to lack of liquidity and supposed insider knowledge.
This results in the following scheme with the two remaining classes:

<table>
<thead>
<tr>
<th>Listed</th>
<th>Non-listed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Property derivatives based on direct real estate</td>
<td>Property derivatives based on direct real estate</td>
</tr>
<tr>
<td>Property derivatives based on non-listed indirect real estate</td>
<td>Property derivatives based on non-listed indirect real estate</td>
</tr>
<tr>
<td>Property derivatives based on listed indirect real estate</td>
<td>Property derivatives based on listed indirect real estate</td>
</tr>
<tr>
<td>Property derivatives based on a direct real estate index</td>
<td>Property derivatives based on a direct real estate index</td>
</tr>
<tr>
<td>Property derivatives based on a non-listed indirect real estate index</td>
<td>Property derivatives based on a non-listed indirect real estate index</td>
</tr>
<tr>
<td>Property derivatives based on a listed indirect real estate index</td>
<td>Property derivatives based on a listed indirect real estate index</td>
</tr>
</tbody>
</table>

The non listed property derivatives based on a direct or non listed indirect property index are most feasible.

For the indices on direct property the IPD is the only widespread recognized alternative in Europe. For the indices on indirect non-listed property the INREV is the only alternative in Europe. The IPD is the best to use in general and for this study. Almost all derivatives transactions, currently occurring, are based upon the, valuations based, IPD index since it represents the underlying property the best. Although there are some issues like smoothing⁶, it does not have a leverage effect like the INREV does, besides that it is possible to construct an index on each separate national market and sectoral market while with the INREV index it is not possible to construct an index on each submarket. This is due to the fact that the INREV index is constructed of non listed funds that all have their own strategy regarding which market to invest in.

So the IPD family is best to use. With family is meant all the IPD indices that are available. Those are national IPD indices, sectoral IPD indices, monthly, quarterly and annually indices and indices on components of returns like for example the income component of property.

§ 2.2.4 Property derivatives types

When decided is that the IPD index will be used in this study there is only one last distinction to be made, the distinction between the different types of derivatives. Four different types are recognized, these are futures/forwards, options, swaps and structured notes. Futures and forwards are almost the same type of derivatives and are treated in this study as the same since they do not have any, for this study, relevant differences. They are described shortly below:

Forwards/futures:

"It is an agreement to buy or sell an asset at a certain future time for a certain price" (Hull, 2005, p.XX)

---

⁶ Smoothing is the underestimation of volatility by valuers of property due to adapting valuations to previous valuations.
A swap:
“A swap is an agreement between two companies to exchange cash flows in the future. The agreement defines the dates when the cash flows are to be paid and the way in which they are to be calculated."
(Hull, 2005, p.XX) A swap can be seen as a portfolio of forwards with different maturities.

Structured notes:
“Structured notes are debt securities in which the repayment of interest, and sometimes principal, is tied to movements in an underlying index and/or have embedded options or forwards”.
(Hull, 2005, p.XX)

Options are available in two main tastes, call options and put options. Based on these tastes there have been dozens of more exotic options been issued.

"A put option gives the holder the right to sell the underlying asset by a certain date for a certain price."
"A call option gives the holder the right to buy the underlying asset by a certain date for a certain price."
(Hull, 2005, p.XX)

<table>
<thead>
<tr>
<th>Table four; cash flow scheme when buying a property index certificate</th>
<th>Expiry date</th>
<th>Obligation of buyer</th>
<th>Obligation of seller</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forwards/futures</td>
<td>Fixed expiry date</td>
<td>To pay an agreed price at ( t = 0 ).</td>
<td>To sell the underlying at ( t = 1 ) for the agreed price to the buyer.</td>
</tr>
<tr>
<td>Options</td>
<td>The buyer of the option has the right to exercise at any time within a certain period.</td>
<td>To pay the option premium on the put or call option.</td>
<td>To buy/sell the underlying for the exercise price when the buyer exercises his put/call option.</td>
</tr>
<tr>
<td>Swaps</td>
<td>Fixed expiry date</td>
<td>To pay the LIBOR rate plus X% per period.</td>
<td>To pay a return based on an index or other underlying per period.</td>
</tr>
<tr>
<td>Structured notes</td>
<td>Fixed expiry date</td>
<td>To pay the nominal amount plus a premium at ( t = 0 ).</td>
<td>To pay a return based on an index or other underlying per period.</td>
</tr>
</tbody>
</table>

It is expected that the market will develop as follows (Reuters, 2006): the derivatives now in use are swaps, based on the IPD index, and PIC’s. Roughly about 60 to 70% of the total market. These standard derivatives will develop first, it is expected that later on in the development of the market more exotic products will be developed, the range of products will grow. This can result in a highly diversified market with all kinds of property derivatives on different indices. However it will take some time before the market will be fully developed.

This means that now and in the near future only the standard property derivatives will develop, these are PIC’s and swaps which are based on the IPD index. These will be studied further on in this study. First will briefly be explained what these property derivatives are.
§ 2.2.5 PIC's and swaps; the property derivatives discussed in this study

Property Index Certificates
A PIC is structured as a Eurobond7, issued by a large financial institution. The bond has a certain maturity. Over this maturity the issuer of the bond pays interest to the holder. The interest that is paid by the issuer to the holder of the bond is set equal to the returns of the IPD index. The income return of this index is paid per period, for example per quarter, the capital return is accumulated over the maturity of the bond and paid in total at the redemption of the bond, at the end of the maturity.

Because the interest payment is not based on the general interest rate but is based on the IPD index this is not a normal bond and is called a derivative, a structured note. The cash flow scheme is shown in §2.2.2.

Property swaps
Here the cash flow that is exchanged is the IPD total return over a certain amount for a LIBOR rate plus a certain risk premium. This all over a pre agreed period. It looks as follows in a cash flow scheme:

The main goal of this study is to show the relationship between selling property derivatives, PIC's and property swaps, and the risk and return of the investment portfolio. In the remainder of this study when property derivatives are mentioned only PIC's and property swaps are meant.

§ 2.3 Definition seller of risk
The main subject of the research question is the seller of risk. In order to avoid a misunderstanding the seller of risk is clearly defined below.

"The seller of risk is the counterparty that receives a premium or a discount for the disposal of property related returns."

The seller of risk is the seller of the property derivatives, the investor who sells some kind of direct or indirect property exposure for a premium or a discount. In this case it is the one who sells the PIC, pays the IPD returns and receives the nominal amount plus premium upfront. Or in case of swapping, the

---

7 Eurobond: A bond is a security that pays of interest to the holder, a Eurobond is a bond which is issued across the national border of the institution in another currency.
seller of risk is the one who pays the IPD returns of the swap and receives the LIBOR plus risk premium per period.

Past examples of sellers of risk have been insurers, pension funds, hedge funds and property companies. The different type of sellers or risk is not important in this context since it does not effect the relation between selling property derivatives and the risk and return of the investment portfolio of a seller.

However sellers of risk can have different investment portfolio's which is relevant for this study.

Possible different investment portfolio's can be:

- Direct property plus property derivatives
- Indirect property plus property derivatives
- Direct and indirect property plus property derivatives
- Only property derivatives.

The investment portfolio will be discussed below.

**§ 2.4 Definition of investment portfolio**

The investment portfolio differs per seller of risk, as seen above various investment portfolio's with property derivatives are possible. This study only focuses on so called "all property" portfolio's and not on mixed asset portfolio's with stock and fixed income products. The different, all property, possibilities are described below.

1. Direct property plus property derivatives; Here the investor has a portfolio of direct property and the liabilities of selling property derivatives.
2. Indirect property plus property derivatives; here the investor has a portfolio of indirect property securities. These can be listed or non-listed indirect real estate.
3. Indirect plus direct real estate plus property derivatives; a third possibility is a portfolio of all the components, direct, indirect and property derivatives. Here the risk and return characteristics are complex and influenced by many factors. The same reasons as above can apply for the investor to buy or sell property derivatives.
4. Only property derivatives; something that does not often occur is an investor with only property derivatives. So far only hedge funds and intermediaries with a temporary position do have portfolios with solely property derivatives.

This study focuses on the case that happens the most\(^8\), which is the one where an investor with an investment portfolio of direct property sells property derivatives. That is because for this investor the advantages are the greatest:

- When a market downturn is expected selling property derivatives is much more cost effective then selling direct property, this is due to the transaction costs of selling direct property.
- Thereby one has got the possibility to regain the economical benefices of the direct property after a few years.

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\(^8\) Based on experiences of Protego in the UK.
In the direct property market the largest out performance can be gained due to the management intensive character of managing direct real estate and the full control one has over the direct property. With the selling of property derivatives this out performance can be magnified. Thereby are direct property investors the least experienced with property derivatives and need most help.

§ 2.5 Definition of return
According to Van Gool, Jager and Weisz(2000) investing is the fixation of capital with the aim of receiving cash flows in the future. The expected return over the capital is important and the risk involved getting that return. This risk is discussed in the next paragraph. The return is the reward for bearing the risk; for sacrificing capital for an unknown future.

The formal definition of return used in this study is: "The annual return on an investment, expressed as a percentage of the total amount invested." (Investorwords, 2006) It is often also called the rate of return or return on investment(ROI).

The return in this study used is the average, annual, total return over the investment portfolio during the holding period.

This study will model the returns of the investment portfolio. It is possible that the investment portfolio, consisting of direct property and property derivatives, are part of a bigger portfolio. The returns on the bigger portfolio will not be taken into account. With total return is meant the income and capital return.

Since the investment portfolio contains a direct property portfolio the study will focus on the annual returns of the investment portfolio. Annual returns can be very different over the years of the holding period of the investment portfolio. This is because when a direct property portfolio is acquired acquisition costs of up to 6% are paid. This reduces the return on the portfolio that year significantly. That's why the average annual return over the holding period will be modelled.

§ 2.6 Definition of risk
Risk is often confused with uncertainty and volatility, that's why risk is defined below.

Definition risk:
"The quantifiable likelihood of loss or less-than-expected returns"  
(Investorwords, 2006a) In the context of this study the risk becomes than:
"The probability that the return of the total investment portfolio will be below a certain threshold value."

How this study indicates risk is discussed in chapter three. In this paragraph is discussed which risk to indicate. It is essential to categorize risks in order to get an overview which risks to focus on.

Text is translated from the Dutch language.
This study focuses on the strategic, financial, risk of an all real estate investment portfolio consisting of a long position in direct real estate and a short position in PIC's or swaps.

This study focuses on the risks involved with the investment portfolio. When zooming in on the investment portfolio one can distinguish three types of risks.

**Strategic, tactical, operational**

- Strategic risks are the risks of not meeting your strategic goals. In this context the investor wants the investment portfolio to perform. The risk of underperformance of the total portfolio is the strategic risk.

- Tactical risks are the risks that one of the instruments used to fulfill the strategy are not performing adequately. In this case the instruments used to fulfill the strategy are a long position in direct real estate and a short position in PIC's or swaps. Examples in this context are:

  o The risk that the long position of direct real estate does underperform to what was expected.
  o The risk that the short position of PIC's or swaps does underperform to what was expected.

- Operational risks are day to day risks involved when doing tactical manoeuvres. Examples of operational risks of PIC's or swaps are (Hasselt, 2003):
  o Credit risk, the risk that a counterparty defaults
  o Legal risk, the risk that a contract cannot be enforced
  o Human error risk, the risk of a human failure
  o Settlement risk, the risk of default when one party has already fulfilled its obligation.

Examples of operational risks of direct real estate are numerous, often occurring risks are vacation risk and rent renewal risk.

**§ 2.7 Conclusion**

The most important concepts are defined in this chapter. The property derivatives that are going to be taken into account are property swaps and PIC's, the investment portfolio consists of direct property and the obligations of the sold property derivatives. The seller of risk is the investor who pays the IPD returns and receives compensation for this. The risk is defined as the probability that the return is below a certain threshold value and the return is the annual average return expressed as a percentage of the invested capital.

In the next chapter the risk of the investment portfolio will be modelled.
Section B; Chapter three; Risk model:

§ 3.1 Introduction
In this chapter the risk of the investment portfolio containing direct property and property derivatives will be modelled. In chapter two the risk we want to model was discussed, it is the strategic, financial risk of the investment portfolio. This risk is defined as:

"The probability that the return of the total investment portfolio will be below a certain threshold value."

This chapter is set up in the following way. First an appropriate expression of risk will be chosen that will be the output of the model. An important assumption will be tested and the standard deviation for the property portfolio and the property derivatives will be discussed. These will be find by reviewing the literature and interviewing property professionals. At the end the factors and relations that determine the risk will be reviewed and the chapter will be concluded.

§ 3.2 Model output: Risk and volatility expression
§ 3.2.1 Introduction
It is important to find an expression for risk because this will be the output of the model. Decomposing the output, the expression of risk, into elements is the start of the modelling process.

The risk that must be expressed is "the probability that the return of the total investment portfolio will be below a certain threshold value." This is already an output which can be used to set up the model. However the volatility of the investment portfolio will also be used as an output parameter of the model. This is because the probability of underperformance of the return is dependent on the return of the investment portfolio and the volatility of this investment portfolio as will be shown below. The logic behind this is as follows: whenever the investment portfolio has a higher return the probability of a lower return will diminish, also whenever the volatility of the investment portfolio is lower with a constant return the probability will also diminish. In this way a high return can camouflage the fact that the return of the investment portfolio has become more volatile. To prevent this, the volatility of the portfolio is also expressed in the model in order to indicate the risk.

First an expression for the volatility will be found and this expression will be used later on to express the probability of underperformance. This expression for the volatility will be found by reviewing the literature. There are several alternatives, after reviewing them the most appropriate one will be chosen. At last in this paragraph will be showed how to use the volatility in order to calculate the probability of underperformance.

§ 3.2.2 Lower partial moment(LPM)
The lower partial moment measurement of risk was first introduced by the famous Markowitz\textsuperscript{10} in 1959. The lower partial moment is an expression that is based upon the differences between the average returns and the realized returns in the past over a certain period. The more differences there are the

\textsuperscript{10} Markowitz: founder of the mean variance model. Basis of diversification theory.
more volatile the asset is and the higher the financial risk. The specific thing of the LPM technique is that the differences are powered by \( n \). The formula is as follows:

\[
LPM = \sqrt{\frac{1}{N} \sum_{i=1}^{N} (r_i - \hat{r})^p}
\]

Where:

- \( LPM \) = Lower partial moment
- \( N \) = number of observations
- \( r_i \) = return at time \( i \)
- \( P \) = power
- \( \hat{r} \) = average returns over certain past period

The higher the \( n \) the more important outliers become. Because whenever \( n \) is higher the large differences are powered more and will have a larger impact on the LPM. The higher \( n \) the more sensitive the indicator is for large differences.

Since it is a single measurement indicator with no assumed probability distribution it is not possible to assign probabilities to a certain outcome. So the probability of underperformance cannot be calculated.

Furthermore are positive as well as negative deviations from the average perceived as volatility, this while positive deviations from the average are clearly not perceived as risky by investors. Another disadvantage is that it with a higher \( n \) the indicator is more sensitive to large differences.

§ 3.2.3 Mean Absolute Deviation (MAD)

The mean absolute deviation does look at the same differences as the previous measurements, however it does not multiply them. That's why outliers do not have that much influence with this measurement. It does not distinguish positive deviations from negative deviations. The MAD is calculated as follows:

\[
MAD = \frac{1}{T} \sum_{t=1}^{T} |R_t - E(R)|
\]

Where:

- \( MAD \) = Mean Absolute Deviation
- \( T \) = Time till maturity
- \( R_t \) = Return at time \( t \)
- \( E(R) \) = Expected return

Main advantage is that it is easy to interpret, disadvantages are that it does not distinguish between positive and negative deviations and that the MAD cannot be used to calculate the probability of underperformance.
§ 3.2.4 Standard deviation/variance

The most popular indicator for volatility is the standard deviation or, if squared, the variance. It is widely used in the financial industry as a risk measurement. The standard deviation is a lower partial moment with \( n = 2 \). The standard deviation is the "expected absolute value of the difference between the random variable and its mean." \( \text{(Biglova, 2004)} \).

The standard deviation is calculated as follows:

\[
\sigma = \sqrt{\frac{1}{n} \sum_{i=1}^{n} (r_i - \bar{r})^2}
\]

Where:

- \( \sigma \) = standard deviation
- \( n \) = number of observations
- \( r_i \) = return at time \( i \).
- \( \bar{r} \) = average returns over certain past period

The standard deviation of past returns with the average return is measured. A higher standard deviation means a higher dispersion around the mean or expected value so more uncertainty and volatility.

Main advantage is that it is easy to calculate and easy to interpret. Main disadvantage is that positive as well as negative differences to the mean or expected value are viewed as volatility which increases the risk. This while positive outliers are clearly not perceived as risk by investors.

If returns are normally distributed the standard deviation is, together with the mean, parameter that describe the distribution. It is possible then to calculate the probability of a negative return. However the annual returns must be normally distributed.

§ 3.2.5 Downside deviation, semi variance

An improvement on the standard deviation is the downside deviation, also called semi variance. It is almost the same although instead of using all returns only the returns below the mean are used. This is based on the idea that investors only perceive any downward deviations as risk. The figure below shows the difference with the standard deviation.
It is calculated as follows:

\[
\sigma = \sqrt{\frac{1}{n} \sum_{i=1}^{n} \text{Max}[0, (E(r_i) - r_i)]^2}
\]

Where:

\[N\] = Number of observations  
\[E(r_i)\] = Expected return of asset \(i\).

The main advantage of this measurement of risk is that it only takes into account the downside deviations of the returns with respect to the average. Thereby it is easy to understand. An important disadvantage of this measurement is that it is not commonly used and not much data of the downside deviation on property is available with respect to the data on the standard deviation of property.

§ 3.2.7 Selecting expression for volatility

After reviewing the four alternatives the standard deviation will be chosen as the indicator for the volatility. The standard deviation is the only indicator which can be used to calculate the probability of underperformance when assumed is that the returns are normally distributed. If the returns are normally distributed then it does not make a difference that also the positive deviations are measured as volatility because the distribution is symmetrical. So the downside deviation is the same as the standard deviation when returns are normally distributed. Furthermore is volatility mostly measured as the standard deviation and is data on the volatility of property, if available, only available measured as the standard deviation.

The expression of volatility is always valid, however for the calculation of the probability it has to be assumed that the returns are normally distributed. Later on in this chapter it will be showed whether this is a reasonable assumption. How to calculate the probability of underperformance of the investment portfolio with the return and the volatility will first be showed.

§ 3.2.8 Calculating the probability with the volatility

When the returns are assumed normally distributed and the volatility is calculated then the probability of underperformance is easy to calculate. Recall that the risk we want to measure is the probability that the total return of the investment portfolio will perform below a certain threshold return. This probability can be described, when assumed is that returns are normally distributed, as follows:

\[
Z = \frac{R_t - E(r)}{\sigma}
\]

where:

\[R_t\] = the threshold return  
\[Z\] = probability for a normal distribution with mean is 0 and a standard deviation of 1.  
\[\sigma\] = Standard deviation
$E(r) = \text{Expected return}$

§ 3.2.9 Return distribution of property returns

In this paragraph we will check whether the assumption that the annual property portfolio returns are normally distributed is true. We need this assumption of an underlying return distribution in order to calculate the probability of underperformance, or in other words, the risk of the investment portfolio.

Below we present data from earlier studies on the return distribution of property. We use two criteria in order to determine whether a distribution is normal, the skewness of a distribution and the kurtosis. After reviewing these two aspects of a portfolio we look at the data in order to determine whether we can reasonable assume that annual direct property portfolio returns are normally distributed.

Skewness (Brown, Matysiak, 2001)

This is a measurement of asymmetry of the return distribution. Positive skewness means that the distribution has a tendency to more positive values while a negative skewed distribution has a fatter negative tail. This is also shown below in the figures:

![Negative and positively skewed distributions](image)

Negatively skewed.  
Positively skewed.

The skewness of a distribution can be caused by mainly market conditions. When market conditions worsen the distribution tends to skew negatively.

Kurtosis (Brown, Matysiak, 2001)

This is a measurement that shows how flat or how peaked a certain distribution is. A high kurtosis implies a peaked distribution with fat tails. A low kurtosis implies a flat distribution with narrow tails. This is shown below in the figures.

![High and low kurtosis](image)

High value of kurtosis  
Low value of kurtosis.

A normal distribution has a kurtosis value and skewness value of zero. The Jarque-Bera statistic tests whether or not these values are jointly equal to zero.
Empirical evidence previous studies

As described before we want to know how annual returns of a direct property portfolio are distributed. We now know the tools which describe these, it's time to review the data. Various studies focus on the return distributions of direct real estate portfolio's. And all with mixed results. For example Brown and Matysiak(2001). They use annual return data of 100 UK properties that track the IPD data well. They find that the kurtosis and leptosis is normal for annual returns for sectors and larger portfolios, consisting of 750 properties and more. Maurer et al(2003) also check the normality of annual real estate returns, they use the complete IPD index from the UK, the NPI from the US and IMMEX index from Germany. They check with three normality tests whether the annual returns, from 1987 to 2001, from these three real estate indices are normal. They find normality for all three indices. Brown(1985) also showed that as the holding period increases real estate returns tend to be normal. These studies show that annual returns for real estate portfolio's are normally distributed.

Although there is considerable evidence that returns over periods shorter than one year, quarterly and daily returns, are not normal distributed we find it reasonable to assume that annual property returns are normally distributed based on the evidence above. This because evidence over longer periods than one year suggests that returns are normally distributed. These contradictory findings may be explained by the fact that the product of n stochastic variables that are non-normally distributed is normally distributed when n is high enough. So even if the daily returns are not normally distributed, the product of 260 daily returns is. This may explain the findings above.

When assuming a normal distribution we need to know the return and the volatility, represented by the standard deviation, in order to calculate the risk. The return will be discussed in the next chapter, the standard deviation below.

§ 3.2.10 Conclusion

We decided to use the standard deviation as an expression of the volatility of the investment portfolio. If the returns are normally distributed then we can calculate the risk, the probability of underperformance, with the use of the following formula:

$$ Z = \frac{R_t - E(r)}{\sigma} $$

To calculate this probability we need to know the standard deviation of the investment portfolio and the expected return. We will discuss these respectively in §3.4 and in the next chapter. First we will check how reasonable it is to assume a normal distribution.

§ 3.4 Standard deviation of the investment portfolio

In this paragraph will be found which input parameters determine the standard deviation of the investment portfolio. This is done by breaking it down into multiple elements. Each time will be checked whether it is possible to identify the determinants of the element and if there is a quantitative relation known between the determinants and the element. When these conditions are met the determinant will be reviewed if it can be broken down further by the same procedure. If it is not possible to identify the determinants or the relation, than the element will be used as an input parameter for the model.
When reviewing the literature there is no literature available on the determinants of the $\sigma_p$ of a portfolio consisting of direct property and property derivatives since property derivatives are a new phenomenon. However the literature for portfolio's in general consisting of two assets can be reviewed. Markowitz(1959) stated that the variation of a portfolio containing n assets is the weighted sum of the variances plus the covariances of the assets, this resulted in the following formula:

$$\sigma_p^2 = \sum_{i=1}^{n} x_i^2 \sigma_i^2 + \sum_{i=1}^{n} \sum_{j=1}^{n} x_i x_j \sigma_{ij}$$

Where:
- $\sigma_i$ = standard deviation of asset i.
- $\sigma_p$ = standard deviation of portfolio.
- $\sigma_{ij}$ = covariance of returns between ith and jth asset.
- $x_i$ = weight of asset i.
- n = number of assets.

This is in agreement with the general modern portfolio theory\(^\text{11}\) from Markowitz. The modern portfolio theory (MPT) states that diversifying assets reduces the risk due to non-perfect correlations. Whenever the correlation between two assets is not perfect than the two assets cancel out each other extreme values which reduces the total risk of the portfolio.

When this formula is applied on our investment portfolio the standard deviation of the investment portfolio then becomes:

$$\sigma_{IP}^2 = x_{re}^2 \sigma_{re}^2 + x_{pd}^2 \sigma_{pd}^2 + x_{re} x_{pd} \sigma_{re} \sigma_{pd} \rho_{repd}$$

Where:
- $\sigma_{re}$ = standard deviation of direct property portfolio.
- $\sigma_{pd}$ = standard deviation of property derivatives.
- $\rho_{repd}$ = correlation of returns between direct property and property derivatives.
- $x_i$ = weight of asset i.

This shows that it was possible to identify the determinants of the $\sigma_p$ and to quantify the relation. The formula above has broken down the risk of the portfolio into several elements.

- The weights of the assets.
- The standard deviation of the direct property portfolio.
- The standard deviation of the property derivatives.
- The covariance of the returns of the property derivatives and the direct property portfolio.

\(^{11}\) See appendix B for a more thorough description of portfolio theory.
§ 3.5 Standard deviation of the property derivatives

Literature on the standard deviation of the property derivatives is not yet available due to the recent upcomin of property derivatives. However when we make some minor adjustments it is possible to derive standard deviation of the property derivatives. In determining the standard deviation of property derivatives we make a distinction between the PIC and the swap. Below is showed how the volatility of the property derivatives is determined and why.

§ 3.5.1 PIC's

Recall that the PIC is a financial contract which assures that capital is paid upfront in return for the IPD market return over the maturity of the PIC. See the scheme below.

Here can be seen that the only uncertain cash flows are those from the IPD Index. The only volatility involved with the PIC is thus the volatility of the IPD index.

There is no literature on the determining components of the IPD index volatility, however since it represents the market it's volatility is almost the same as the market risk. There are a few aspects why the IPD index does not fully replicate the market.

- Smoothing
- Representativeness bias

Smoothing

Smoothing is the problem of underestimated risk by valuation based indices, this is due to the valuation aspect of the index. Geltner(1997) defines valuation smoothing as follows: “aggregate valuations include the systematic bias of the effect of past market values on the current appraisals. This effect of past market value on the current appraised value is what is known as “appraisal smoothing”.

Smoothing is caused by some main factors(Marcato, 2004) like the:

- Valuation spread over time, this means that valuations of properties are corrected by the valuer to come closer to valuations of older properties.
Inertia: this is the phenomenon where valuers wait too long with updating their older market beliefs for their new valuations, this is also the reluctance of valuers to report changes in value below the 1%.

There is various research on the de-smoothing of an index, all kind of algorithms are designed in order to provide a more accurate market risk estimate over past returns.

Representativeness bias
The IPD index contains portfolio's of assets from all kind of larger investors like institutional investors and listed and non-listed funds, however the smaller investors are not represented. The total real estate underlying the index is just a portion of the total real estate available. For example in the UK where the IPD has the longest track record, only X% of the total property is comprised in the index.

Although the IPD index does not fully replicate the market we use this as a good enough proxy. This study will assume that the market is perfectly represented by the IPD index. This means that the standard deviation of the market is the standard deviation of the PIC, in formula:

\[ \sigma_{pt}^2 = \sigma_m^2 \]

Where:
\[ \sigma_{pt}^2 \] = Variance of property derivatives
\[ \sigma_m^2 \] = Variance of market

Below will be the market volatility discussed and, if possible, broken down into its determinants.

Market volatility
Various studies study the effect of macro economical variables on the property market. Ling and Naranjo(1996 and 1999) find that expected, unexpected inflation, interest rates, the market portfolio and several other macroeconomic variables are risk factors for the property market. Eichholtz et al(1998), Liu and Mei(1996) find that exchange rate risk adds to the market risk when for countries and continents specific. Ciochetti et al.(2003) state that one way of estimating market risk is correcting the observed market risk, in the form of the standard deviation over past returns, and correct them on some factors. They state that the standard deviation is dependent on the sector of the market. Brown and Matysiak(2000) recognize three different systematic risks that affect all objects of the market.

- General economic conditions
- Changes in finance rates
- Taxation

Although several elements where recognized that determine the market volatility they could not be used in the model because the relation between these elements and the market volatility can not yet be quantified. So we use the market volatility as an input parameter for the model since it cannot be broken down further.
§ 3.5.2 Swaps
Recall that a swap is a swap of cash flows where the seller of risk sells the IPD leg and wants in return a LIBOR rate plus a x% premium in return. See the cash flow below.

The liabilities of the swap are the same for the seller of risk. So the volatility of the liabilities are the same as for the PIC, this volatility is the volatility of the property market, see the previous paragraph.

However instead of a premium received by the seller at the start, as when selling a PIC, the seller receives periodically a LIBOR rate plus x% premium. The x% premium is a fixed number and does not influence the volatility of the swap. The LIBOR rate however is an interest rate that changes over time and is uncertain.

The LIBOR rate is the interest rate at which banks lend to each other. It is viewed as the minimum lending rate. There are several LIBOR rates for various lending periods. For example a 12 month LIBOR is the interest rate at which banks lend each other for a maturity of 12 months. The 6-month LIBOR rate is most often used as opposing leg for the IPD leg in a swap.

Although the 6-month LIBOR rate is a rate that is volatile we use a fixed rate, we do this by swapping the 6-month LIBOR rate for a fixed rate on the capital market. This is done because of the following reasons:

- The core business of the property investor is property and not interest rates, so he can better bear property risk and not interest rate risk.
- The interest rate is very difficult to forecast and has a non constant volatility.
- There are many instruments on the capital market for swapping the LIBOR rate for a fixed rate.

So this study assumes that every property investor swaps the 6-month LIBOR rate for a fixed rate and the 6-month LIBOR rate and in this way the volatility of a swap is the same as the volatility of the PIC which on his turn resembles the market volatility.

§ 3.6 Standard deviation of the direct property portfolio
When looked at the determinants of volatility of a single asset in general one can make a distinction between market volatility and tracking error risk. This is shown in the formula below:

\[ \sigma^2 = \sum x_i^2 \sigma_i^2 + x_i \sum x_j \sigma_i \sigma_j \rho_{ij}^2 \]

Where:

Formula 3
\( \sigma_{\nu}^2 \) = Variance of the direct property portfolio

\( \sigma_m^2 \) = Variance of the market

\( \sigma_{\nu}^2 \) = Variance of the tracking error

\( \rho_{\nu\nu} \) = correlation between the market and the tracking error

\( x_m \) = weight of the market return

\( x_{\nu} \) = weight of the tracking error return

In this case it is always that the weight of the market standard deviation is equal to the weight of the tracking error because each return of the direct property portfolio consists of a tracking error return and a market return. This means that:

**Formula 4**

\[
\sigma_{\nu}^2 = \sigma_m^2 
\]

The standard deviation of the market and of the tracking error are discussed below.

§ 3.6.1 Standard deviation of the market:
The market risk of the direct property portfolio is the same as the market risk discussed above for the property derivatives. This will not be further mentioned here.

§ 3.6.2 Standard deviation of the tracking error:
The tracking error risk is influenced by the Beta of the portfolio and the diversification level of the portfolio. In formula this looks as follows (Byrne and Lee, 2000):

**Formula 5**

\[
\sigma_{\nu}^2 = \sigma_m^2 \cdot (\beta - 1)^2 + \sigma_t^2 
\]

Where:

\( \sigma_{\nu}^2 \) = tracking error risk

\( \sigma_t^2 \) = non-systematic risk

Assumed is that there is no relationship between the Beta and the residual risk of a portfolio. As we can see above the tracking error can be broken down into the elements market risk, Beta and non-systematic risk. The market risk we have discussed before, the determinants of the tracking error risk are discussed below.

Another small stream of research focuses on the overall risk factors of the tracking risk of property. Jonas Lang LaSalle has developed a risk model in collaboration with the IPD. The approach was tested by JLL and IPD. They find that of the 130 randomly created portfolio's the following risk factors were significantly correlated with the tracking error size:

- Lot size
- Sector balance
- Location concentration
• Weighted sector beta and
• Tenant concentration

However it is not possible to quantify the relation between the determinants above and the tracking error risk. So the Beta and the non-systematic risk will be used as determinants for the tracking error risk since it is shown in formula 5 that this relation can be quantified.

§ 3.6.2.1 Beta of the direct property portfolio:
The Beta measures the sensitivity of the direct property portfolio to market fundamentals, it is the covariance between the property portfolio and the market index, for example the IPD index. The property portfolio can be more sensitive to market fundamentals when for example the vacancy rate is relatively high. Or the strategy of the portfolio is risky, for example based on improving low quality property. There is little research that shows the relation between portfolio characteristics and the Beta of a portfolio. So the Beta cannot be broken down in other elements and is as such an input parameter for the model.

§ 3.6.2.2 Non-systematic risk of direct property portfolio
More is written about the non-systematic risk of a portfolio of direct property. Various studies adress the factors that determine the non-systematic risk. Potential sources of specific risk are according to Byrne and Lee(1999): Location, regional and local economic conditions affecting demand and the comparative supply of similar properties, tenants creditworthiness, lease structure etc. According to Viezer(2000) they are: Lease terms, operating and financial leverage, tenant mix and location.

Non-systematic property risk should be possible to diversify away. The principle of diversification is, as we have seen, “not putting all your eggs in one basket”. By spreading the return determining characteristics of your portfolio you reduce the non-systematic risk. When the portfolio approaches the market portfolio the non-systematic risk approaches zero and the portfolio only has systematic risk. This is shown in the figure below.

A lot of literature has been written on the relation of size to diversification level. A classical paper on diversification of securities is the one of Archer and Evans, written in 1968. They investigate the relationship between the rate of reduction of portfolio variation by adding randomly securities to a portfolio. The following hypothesis is tested:

• If the number of securities in a portfolio is increased so that the market portfolio is approached, one would expect that the portfolio variation would decrease to approach the variation of the market portfolio.
• In other words, that the unsystematic risk approaches zero by an asymptotic function.

They concluded that the marginal effect of adding securities diminishes rapidly after the 10th security. Elton and Gruber (1977) approach the diversification effect more analytically and catch it in formula's. All this research was done on equity data. The first studies concerning the diversification level of property in a quantitative way only emerged in the late 80's. This was due to the lack of empirical data needed to study the relation ship. Byrne and Lee (2001) find a significant spearman correlation coefficient of -0.387 between the size of a certain fund and the specific risk of that fund.

Brown (1988) recognizes the following reason why the diversification effect of properties might differ from that of securities.

• Due to the indivisibility of property the weights of the assets in the portfolio are determined by material factors.

This study argues that low correlations between assets increase the portfolio diversification effect. In other words: the lower the inter asset correlation the higher the diversification effect and the fewer securities you need in order to diversify an amount of specific risk away. However the large differences in value between assets can be a factor that makes sure that a lot of properties are needed in order to diversify risk. Brown (1988) uses the following formula for quantifying the effect.

\[
\sigma = A + Q \left( \frac{1}{N} \right)
\]

Where:
- \( \sigma \) = standard deviation of portfolio returns
- \( N \) = number of assets in portfolio.
- \( A \) = Constant
- \( Q \) = Constant

A represents here the systematic part of the risk and \( Q \left( \frac{1}{N} \right) \) the non-systematic part of the risk. Their empirical work resulted in the following constants.

<table>
<thead>
<tr>
<th>Sector</th>
<th>A</th>
<th>Q</th>
<th>R^2</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sim 1</td>
<td>0.0184</td>
<td>0.0118</td>
<td>0.95</td>
<td>40</td>
</tr>
<tr>
<td>Sim 2</td>
<td>0.0139</td>
<td>0.0534</td>
<td>0.91</td>
<td>40</td>
</tr>
<tr>
<td>Sim 3</td>
<td>0.0191</td>
<td>0.0230</td>
<td>0.58</td>
<td>40</td>
</tr>
<tr>
<td>Theoretical</td>
<td>0.0145</td>
<td>0.0309</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

So the non-systematic risk can be estimated by the constant \( Q \) and the number of assets of a portfolio. Although this is a good approximation of the non-systematic risk there are some rough edges on it. The following two reasons account for this:

1. The different values of properties, a portfolio is much less diversified when there are 5 properties of which one accounts for 90% of the total value than with 5 properties which are equal in value.
2. It assumes that all properties have different characteristics, which does not have to occur. 5 properties within the same village and same sector do not diversify as well as 5 totally different properties.

The following literature focuses on identifying the risk diversifying factors and the amount of effect they have on diversifying away unsystematic risk. Eichholtz et al (1995): Returns on different property types are believed to be driven by different economic factors. For example:

- "Offices by office employment, shops by retail sales and industrial properties by manufacturing output."

- They acknowledge the problem that location boundaries are political and not economical.

They study whether it is better to first start diversifying geographically or by sector; they don't find a clear answer, it differs per property type. Viezer (2000) argues as following: The non-systematic risk is caused by economic and geographic differences between properties. He reviews several studies which use different diversifying factors like Hartzell, Hekman and Miles (1986) which use the following factors: Metropolitan statistical area, Property type and Lease maturity. Viezer (2000) describes that Malizia and Simons (1991) diversify economically, this means by location in an economical area, like the MSA. Grissom, Kuhle and Walther (1987) diversify on the following factors: Different markets and Property types. Firstenberg, Ross and Zisler (1988) also used property types and different geographic locations as diversification factors. Viezer (2000) concludes after testing 13 different sets of diversifying factors that the best factors to use are location and property type. Hamelink et al (2000) show that geographic zones based on economic forces outperform geographic zones based on political boundaries.

However although just the number of objects in a property portfolio is a rough way to quantify the level of diversification it is the best there is at the moment. It is known what the most important diversification factors are, location and sector, but these factors cannot be quantified, so they are of no use in this model. If ever these factors are quantified then they can be used to quantify the level of diversification in this model.

§ 3.7 Resume
We have shown various formula's for the components of the volatility of the investment portfolio. The figure below shows the decomposition of the risk of the investment portfolio.
This paragraph will combine the formula's of the standard deviation of the investment portfolio into one formula for the total standard deviation. The one parameter that has not yet been discussed is the correlation between the property derivatives and the direct property portfolio. Since there is no empirical evidence of the correlation between property derivatives and direct property, due to the short existence of property derivatives, we will derive the correlation based on the formula's below.

Recall that the formula for the investment portfolio risk is.

**Formula 1**

\[ \sigma_{ip}^2 = x_p^2 \sigma_m^2 + x_p^2 \sigma_{pd}^2 + 2x_p x_m \rho \sigma_m \sigma_{pd} \]

**Formula 3**

\[ \sigma_{r}^2 = x_p^2 \sigma_m^2 + x_m^2 \sigma_{pd}^2 + 2x_m x_p \rho \sigma_m \sigma_{pd} \]

Combine these two in:

\[ \sigma_{ip}^2 = x_p^2 \sigma_m^2 + x_p^2 \sigma_{pd}^2 + 2x_p x_m \rho \sigma_m \sigma_{pd} + 2x_m x_p \rho \sigma_m \sigma_{pd} + 2x_p x_m \rho \sigma_m \sigma_{pd} \]

where:

**Formula 2**

\[ \rho_{pd} = \rho_{pm} \]

This means that \( \rho_{pd} = 1 \), combine the previous two formulas:
Furthermore assume that $\rho_{mx} = 0$ and

**Formula 4**

\[ x_m = x_{pd} \]

so:

\[ \sigma_{ip}^2 = (x_m^2 + x_{pd}^2 + 2x_mx_{pd})\sigma_m^2 + x_{pd}^2\sigma_{mx}^2 + 2x_mx_{pd}\sigma_m\sigma_{mx}\rho_{mx} + 2x_{pd}x_p\sigma_{mx}\rho_{mx} \]

**Formula 5**

\[ \sigma_m^2 = \sigma_m^2 \]

Combine these two formula's:

\[ \sigma_{ip}^2 = (x_m^2 + x_{pd}^2 + 2x_mx_{pd})\sigma_m^2 + x_{pd}^2(\sigma_m^2 + (\beta - 1)^2 + \sigma_{mx}^2) \]

**Formula 6**

\[ \sigma_{norm}^2 = \frac{Q}{n} \]

Where $Q$ is a constant and $n$ the number of properties in the direct real estate portfolio.

The standard deviation is then:

\[ \sigma_{ip} = (x_m^2 + x_{pd}^2 + 2x_mx_{pd})\sigma_m^2 + x_{pd}^2(\sigma_m^2 + (\beta - 1)^2 + (Q/n)^2) \]

This is the formula for the absolute standard deviation of the investment portfolio containing property derivatives and a direct property portfolio. When we want the standard deviation expressed as a percentage of the amount invested we have to divide it by the amount invested.

\[ \sqrt{\left(x_m^2 + x_{pd}^2 + 2x_mx_{pd}\sigma_m^2 + x_{pd}^2(\sigma_m^2 + (\beta - 1)^2 + (Q/n)^2) \right)} \]

Where:

\[ x_m = \] weight of the direct property portfolio
\[ x_{pd} = \] weight of the property derivatives
\[ \sigma_m^2 = \] Variance of the property market
\[ \beta = \] Beta of the direct property portfolio
\[ Q = \] Constant Q
\[ n = \] Number of objects in the portfolio
\[ X_{inv} = \] Amount of capital invested

§ 3.8 Conclusion

The risk can best be expressed by the probability of underperformance and by the standard deviation of the investment portfolio. The standard deviation of the investment portfolio depends on the holding period, market volatility, the Beta of the property portfolio, number of properties in property, the constant Q and the weight of the property derivatives and the direct property portfolio in the investment portfolio.

These input parameters are related to each other in the following way:
\[
\frac{\sqrt{x_m^2 + x_{pd}^2 + 2x_m x_{pd}) \sigma_m^2 + x_m^2 (\sigma_m^2 * (\beta_i - 1)^2 + (Q/n)^2)}}{X_{inv}}
\]

With this formula it is possible to model the risk. The results of this modelling will be demonstrated by the use of a real life case in chapter six.

In the next chapter the return will be decomposed and calculated.
Section B; Chapter four; Return model

§ 4.1 Introduction
In this chapter the return is modelled of the investment portfolio. First will be determined which indicator will be used for the return on the investment portfolio. After that the revenues and the costs of the direct property portfolio and the property derivatives will be discussed. All the factors that determine the return will be shown in a schematic cash flow scheme at the end of the chapter followed by a conclusion. First an expression for the return is determined.

§ 4.2 Model output; Return expression
§ 4.2.1 Introduction
In the delineation and definitions in chapter two was identified that the return is represented by the average annual return on the investment portfolio over the holding period of the property derivatives. The average annual return is measured because annual returns can differ a lot over the different years of the holding period due to the timing of certain costs such as transaction costs. Showing the effect of adding property derivatives on the return of the investment portfolio in order to determine whether to sell property derivatives or not requires a return indicator that shows the average return over the whole holding period. Since the decision is made for the whole holding period and not for one year.

There are several ways to specify the investment portfolio's return. Two important ways are to calculate it's net present value(NPV) or the internal rate of return(IRR). These are mostly used to evaluate investment projects.

§ 4.2.2 Net present value
The net present value is the present value of all future income streams. The income stream is based on the investment portfolio. All the cash flows from the investment portfolio, consisting of both the property derivatives and the direct property portfolio, are discounted at a certain discount rate. The formula for the NPV is shown below:

\[
NPV = \sum_{t=1}^{n} \frac{C_t}{(1+r)^t}
\]

Where:
- \(C_t\) = the cash flow at time \(t\)
- \(r\) = the discount rate.
- \(NPV\) = Net Present Value

In the NPV model it is assumed that the cash freed from the project, for example cash gained in year 1 while the total period is 10 years is reinvested at the discount rate. The higher the NPV is, the better the investment is. However the outcome is totally dependent on the discount rate. The ranking of various investment projects also changes when the discount rate changes. Whenever the discount rate is higher the NPV of the project with more cash flows at the end of the timeline will decrease faster than NPV's of the other investment opportunities.
Besides that the discount rate is difficult to determine, it represents the risk of a project, the higher the risk the higher the discount rate. The combination of the dependency of the method together with the difficulties in determining the discount rate is the main drawback of the method.

§ 4.2.3 Internal rate of return (IRR)

The IRR is also calculated on the income stream of an investment. The internal rate of return is that return over multiple periods so that the NPV is zero. The IRR is calculated as follows:

\[ \text{Value at } t_0 = \sum_{t=1}^{n} \frac{C_t}{(1 + IRR)^t} \]

The IRR cannot be solved analytically, it can only be solved by an iterative process. Excel has an IRR function that iteratively solves a stream of cash flows for the IRR.

The IRR assumes that the freed capital can be reinvested at the IRR, in general it is not possible to reinvest the capital at the IRR so the total rate of return will be in general lower than the IRR. This is also the reason that the NPV and the IRR method can rank the same projects differently since the NPV reinvests the capital at the discount rate while the IRR method reinvests at the IRR rate.

A method that improves on the IRR is the "modified" internal rate of return. This is explained below.

§ 4.2.4 Modified internal rate of return (MIRR)

The modified internal rate of return computes the IRR but has an explicit reinvestment rate assumption. The freed capital is reinvested at this rate.

The formula is shown below.

\[ \text{MIRR} = \left( \frac{\text{NPV}(\text{reinvestment rate, positive values}) \times (1 + \text{reinvestment rate})}{\text{NPV}(\text{Financerate, negative values}) \times (1 + \text{Financerate})} \right)^{n-1} - 1 \]

§ 4.2.5 Conclusion

In this study we will use the MIRR to measure the return of the investment portfolio. This because the IRR is most used in the financial industry and easy to understand. The MIRR is an improvement on the IRR but as easy to understand. Furthermore does the NPV heavily depends with which discount rate the cash flows are discounted. A discount rate that is dependent on the risk of an investment.

The MIRR is an easy to understand return measurement which takes into account that the freed capital is reinvested at another rate as the IRR. Furthermore it does not require a hard to define discount rate in order to provide the return.

In the next part will be discussed how to determine the income stream, which cash flows do occur? The revenues and costs of the direct property portfolio and the property derivatives will be examined, first will be examined the direct property portfolio.
§ 4.3 Revenues and costs direct property portfolio
§ 4.3.1 Introduction
This paragraph determines what the various revenues of a direct property portfolio are. In the previous chapter the standard deviation of the return of the direct property portfolio was divided into a market return and an excess return performance. They are discussed below.

§ 4.3.2 Market return
The market return can be divided into the elements capital return and income return. The market return is adding up the income and capital return. In formula this looks as follows:

\[ mr = mr_i + mr_c \]

Where:
- \( mr \) = Market return of the direct property portfolio
- \( mr_i \) = Market income return of the direct property portfolio
- \( mr_c \) = Market capital return of the direct property portfolio

They are discussed below.

Market income return
The market income return of the direct property portfolio is the rent receivable minus all the costs that are made which are directly attributable to delivering the income stream, also called operating costs. But this does not include the investment management costs or portfolio management costs which are all the costs involved with managing the paper based assets. The return is expressed as a percentage of the total capital deployed. In formula this looks as follows:

\[ mr_i = rent - oc \]

Where:
- \( Rent \) = The rent of the direct property portfolio, represented by an annual cash flow, expressed as a percentage of the capital invested in the direct property portfolio.
- \( Oc \) = The operation costs of the direct property portfolio

Main determinants are the rent receivable and the operating costs. The rent receivable is dependent on the properties of the space of the property and the space market condition(Wheaton, Dispasquale, 1996). The operating costs are expressed as a percentage of the rent. The costs are expenses for maintenance, management and taxes. The management costs are usually expressed as a percentage of the rent. The taxes depend also on the rent and on the value of the property.

Market capital return
For the market capital return the following IPD definition is used:
"The capital component of total return for each monthly measurement period is calculated net of all capital investment within that period and is expressed as a percentage of the capital employed."(IPDGlobal.com)

The capital return is calculated as follows:

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Where the elements that make up the capital return are:

- \( C_{dis} \) = the capital disinvestment over the period.
- \( C_{inv} \) = the capital investments over the period.
- \( V_0 \) = the capital value at the beginning of the period.

The elements capital investments and disinvestments over the period occur infrequently and cannot be broken down further. The element capital value is determined by dividing the rent minus the depreciation by the yield. This is shown below:

\[
V_0 = \frac{\text{rent} - \text{depreciation}}{y_0}
\]

Where:

- \( y_0 \) = the yield at the beginning of the period.

The rent is discussed above. The yield represents how much investors value a certain income stream. When the yield is high the income stream is valued low due to large risks involved. The yield depends on the risks that are perceived with the income stream such as possible rent decreases, capital depreciation or other property specific reasons.

**Resume**

The figure below shows how the market return is divided into the various elements discussed above.

This study will only focus on the capital return and the income return and will not break these elements further down. This is because as we said in chapter one, for each input variable we will look whether it's effect is not too large on the output of the model. If the effect is too large it will be broken down further into more elements. However since the effect of the market income return and the market capital return is relatively small it is not necessary. Furthermore it is harder to determine the various elements that
make up the capital and income return than estimating the capital and income return itself for the input parameters.

§ 4.3.3 Excess return

The cash flows of the direct property portfolio are not only determined by the general market return of all property in a market. The relative performance of the portfolio with respect to the market together with the market performance determines the return and so the cash flows of the direct property portfolio. The market return and the excess return are added up to form the return of the direct property portfolio. See the formula below.

\[ r_i = m_r + e_r \text{ and } r_c = m_r + e_r \]

Where:

- \( r_i \) = Income return of the direct property portfolio
- \( r_c \) = Capital return of the direct property portfolio
- \( e_r \) = Excess income return of the direct property portfolio
- \( e_r \) = Excess capital return of the direct property portfolio
- \( m_r \) = Market income return of the direct property portfolio
- \( m_r \) = Market capital return of the direct property portfolio

The excess return of a portfolio is determined by superior skills of the management of the portfolio with respect to the market. We distinguish three types of skills portfolio management can have in order to outperform the market (Kaizer, 2005).

**Market skills**

These are the skills of the management to select the right markets. In this study we distinguish markets by sector and country. It is also called the Beta performance of the portfolio. Market skills improve both the income and capital excess returns. For this study we will determine the market skills by adding a certain percentage to the market returns. This percentage is dependent on the management and differs per case. The market skills component has the following effect on the excess income and capital return of the direct property portfolio:

Impact on the income return of the direct property portfolio:

\[ e_r = m_r \cdot (\gamma + \kappa) \]

Where:

- \( e_r \) = Excess income return of the direct property portfolio
- \( m_r \) = Market income return of the direct property portfolio
- \( \kappa \) = Market skills component
- \( \gamma \) = Improvement skills component
Impact on the capital return of the direct property portfolio:

\[ r_{cex} = r_c + r_c \times (\alpha + \kappa) \]

Where:

- \( r_{cex} \): Capital return of the direct property portfolio
- \( r_c \): Market capital return of the direct property portfolio
- \( \kappa \): Market skills component
- \( \alpha \): Selection skills component

**Selection skills**

These are the skills of the management to select the right properties within a certain market. It is also called the alpha performance of the portfolio. The selection skills improve the excess capital return. The selection skills will be calculated by adding a percentage to the capital return of the portfolio. This percentage is dependent on the management and differs per case.

Impact on the income return of the direct property portfolio:

\[ r_{ire} = r_i + r_i \times (\kappa + \gamma) \]

Where:

- \( r_{ire} \): Income return of the direct property portfolio
- \( r_i \): Market income return of the direct property portfolio
- \( \gamma \): Improvement skills component
- \( \kappa \): Market skills component

**Improvement skills**

These are the skills of the management to improve the properties. Since the investor is the owner of the buildings and has full control over them it is able to improve the assets. Improvement skills improve the excess income return and is calculated by adding a percentage to the income return.

The input parameters in the model will be an Alpha, Beta and Gamma component that indicates the excess return of the direct property portfolio. These components differ per portfolio and have to be indicated by the user of the model.
§ 4.3.4 Investment management costs

Besides revenues, which are positive cash flows, there are also costs, negative cash flows, of the direct property portfolio. Property related costs like maintenance costs and property management costs were already identified. However there are also costs on the investment level. One of these costs are the investment management costs (Robinson, Palmer, 2005). These are the costs that are involved with managing paper based assets such as administration costs and due diligence costs. They are expressed as a percentage of the total assets of the direct property portfolio and are not further divided into determining elements. The investment management costs are taken into account annually.

§ 4.3.5 Transaction costs

These are the costs that have to be taken into account when buying and selling direct property. Acquisition costs consist of stamp duty, fees for agents, solicitors and specialist surveys (Robinson, Palmer, 2005). Especially when holding periods are short the acquisition costs can severely damage the returns. Property selling costs are costs like fees for agents, they are paid when the property is sold.

Property costs do not have to be taken into account always when selling property derivatives, this depends per situation. When a PIC is sold and the property is bought especially for selling these PIC's one has to take into account 100% of the transaction costs. When property derivatives are sold as an alternative for selling direct property and buying it back later one does not have to take transactions costs into account. When one buys property in order to keep it during two periods of selling property derivatives one does have to take 50% of the transaction costs into account. The table below provides an overview.

<table>
<thead>
<tr>
<th>Type of decision that is supported.</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Situation:</strong> An investor wants to sell PIC's for the premium and buys direct property especially for this purpose.</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Decision:</strong> He has to choose between this investment alternative and others, so he wants to know the total return and risk of this investment option.</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Situation:</strong> An investor wants to buy direct property to sell PIC's and to keep it in their portfolio.</td>
<td>100%/n</td>
</tr>
<tr>
<td><strong>Decision:</strong> He has to choose whether or not sell PIC's.</td>
<td>100%/n</td>
</tr>
<tr>
<td><strong>Situation:</strong> An investor is already in possession of direct property and expects a downturn in the market. He wants to sell temporarily his exposure.</td>
<td>100%/n</td>
</tr>
<tr>
<td><strong>Decision:</strong> He has to choose between doing nothing and keeping the direct property and selling PIC's for the period.</td>
<td>100%/n</td>
</tr>
</tbody>
</table>
In this study the transaction costs will be taken into account according to the decision the model has to support. Transaction costs will always occur at the start and end of a period.

§ 4.3.6 Conclusion
The following input parameters determine the cash flows of the direct property in the model.

<table>
<thead>
<tr>
<th>Costs</th>
<th>Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transaction costs</td>
<td>Market income return</td>
</tr>
<tr>
<td>Investment management costs</td>
<td>Market capital return</td>
</tr>
<tr>
<td>Percentage of transaction costs</td>
<td>Alpha component excess performance</td>
</tr>
<tr>
<td>taken into account.</td>
<td>Beta component excess performance</td>
</tr>
<tr>
<td></td>
<td>Gamma component excess performance</td>
</tr>
</tbody>
</table>

§ 4.4 Revenues and costs property derivatives
§ 4.4.1 Introduction
The investment portfolio consists of the direct property portfolio and the financial obligations and benefits that are due to the selling of property derivatives. These obligations and benefits will be discussed below. The benefit of selling property derivatives is the premium that one receives while the obligations are the market return that has to be paid to the buyer of the property derivative. The premium for the PIC and the property swap are first discussed.

§ 4.4.2 Premium property derivatives
Investors pay a premium for property derivatives. For PIC's this premium is paid upfront. It is expressed as a percentage over the nominal amount of PIC's bought or sold. With swaps the premiums are paid periodically over the LIBOR rate. In this model the LIBOR rate is swapped for a fixed rate. In both cases the premiums are determined the same way. The only difference is that the PIC premiums are capitalized swap premiums.

The premium is dependent on the market for property derivatives. When interviewing market participants it appeared that there are some beliefs that the premium depends on the following elements:

- Short term expectance of the property market: When investors believe that the property market will perform significantly better on the short term the premium on a property derivative will increase. This is because the only way to profit from this increase in return is by buying a property derivative, buying direct property would take too long.
  Long term expectations do not influence the premiums because investors are able to buy direct property in order to profit from the increase and do not need property derivatives for this.
- The transaction costs of direct property: The higher the transaction costs the more benefits property derivatives have with regard to their alternative, direct property.

Besides these elements that determine the premium that are identified by market participants there are several attempts to formulate a model. These are discussed below.

Some literature is available on the pricing of property derivatives. Bjork and Clapham (2002) argue that there should be no premium for property derivatives such as a swap or a PIC. They use the following hypothetical case:
1. At \( t=0 \) one promises to pay of the IPD returns at \( t=1,2,3 \) and 4 for a LIBOR interest at those times. In other words one sells the IPD-leg of a swap.

2. At \( t=0 \) one borrows 1 euro for the LIBOR rate and invests it in the index. Due to this at \( t=1,2,3 \) and 4 one receives the IPD return and has to pay the LIBOR rate.

3. Due to selling the sold IPD leg one has to pay IPD and receives LIBOR. In total one has no net gains or losses after \( t=4 \) when there is no premium paid.

If there was a premium received for selling the IPD-leg one would receive a premium while not bearing any risk, this would be arbitrage.

Although it sounds right there are some strong assumptions made.

- First of all assumed it that it is possible to invest in the IPD index. This is not possible and to replicate it with direct or indirect property investments is nearly impossible.
- Furthermore no default risk is assumed. Lending against the LIBOR rate is only for default free investors. They are non existent.
- Third is assumed that the property derivatives market is a perfect competition market with plenty of sellers of property derivatives. This is not true, mainly due to the difficulties of replicating the IPD returns only very few investors offer property derivatives.

Patel and Pereira(2006) improve on the model by taking into account credit risk. They find that the fair spread increases with a longer holding period and increases whenever the counterparty has a lower credit rating. The chance of default increases due to these factors. Also the fair spread increases whenever the underlying index is more volatile. This is because the consequences of a default are then worse.

Baum et al(2006) acknowledge that there are some property specific problems to the swap that make the pricing deviate from an equity index based swap. They acknowledge that the tracking error risk, or the basis risk or the impossibility of replicating the index, is one aspect that clearly deviates from the equity based index swap. This is due to index linked problems such as smoothing and due to the high transaction costs of property so that it is not possible to create a replicating portfolio on short term, listed indirect investments are not suitable due to investor sentiment.

We have seen that some elements are identified that determine the premium by market participants and by the literature. Even some qualitative relations have been identified, however no quantitative relations so we cannot break the property derivatives premium further down for this model. We will use the premium as such as input parameter.

§ 4.4.3 Market liability

The costs of the property derivatives are the same as the market returns, since the IPD index represents the market returns. There are some minor differences due to the smoothing effect and the representativeness bias discussed before. The market income return and the market capital return has to be paid per annum to the buyer of the property derivative. As we have seen above the market returns are not broken down into multiple elements in this model because of the arguments provided above.
§ 4.4.4 Conclusion

The following input parameters determine the cash flows of the direct property in the model.

<table>
<thead>
<tr>
<th>Costs</th>
<th>Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market income liability</td>
<td>Property derivatives premium</td>
</tr>
<tr>
<td>Market capital liability</td>
<td>Fixed LIBOR rate</td>
</tr>
</tbody>
</table>

Figure 12: Brief overview decomposition of the return

§ 4.5 Cash flow scheme
All the cash flows are shown below in the table for a maturity of X years.

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Cost/revenue</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year X</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct RE</td>
<td>Income return</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Capital return</td>
<td></td>
<td></td>
<td></td>
<td>y</td>
</tr>
<tr>
<td></td>
<td>Investment management costs</td>
<td>z</td>
<td>z</td>
<td>z</td>
<td>z</td>
</tr>
<tr>
<td></td>
<td>Transaction costs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PIC</td>
<td>Premium</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Market income liability</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Market capital liability</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Swap</td>
<td>Premium</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Market income liability</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Market capital liability</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fixed LIBOR rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>Net</td>
<td></td>
<td></td>
<td></td>
<td>X+y-z</td>
</tr>
<tr>
<td></td>
<td>MIRR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Because the Swap and the PIC have a different cost and revenue structure they are separately discussed in the model.

The model supports all holding periods for up to a holding period of 10 years. Ten years is chosen because this was thought to be the maximum period a PIC's or swap would be traded for. The model can be extended if it appears to be that the maturity of the property derivatives is often more than 10 years.

§ 4.8 Conclusion

The return will be expressed by calculating the modified internal rate of return over the cash flows. This because it is most easy to interpret for the users of the model, the investor, and it most accurately reflects the return of the investment portfolio.

For each element that determines the return of the investment portfolio we have checked whether it was possible to further decompose it into more elements, and if so if there was a known quantitative relation between the elements. If this was the case then it was decomposed if not than the element was not decomposed and used as an input parameter for the model.

The method ensured that the following elements that determine the return of the investment portfolio are the input parameters of the model: market capital return, market income return, alpha, beta, gamma component, transaction costs, investment management costs, premium, market income liability and market capital liability.

In the next chapter the model will be tested.
Section C; Chapter five; Model test

§ 5.1 Introduction
This chapter provides a test of the model. The model is tested for how sensitive the model output is for the single input parameters. Right now there is no empirical data available of the risk and return of an investment portfolio with property derivatives. However whenever this data is available it is possible to test whether the risk and return match with the empirical evidence. But till then it is not possible to test this and so it will not be tested. The correctness of the calculations has been checked by Prof.dr.ir. Van Berkum, professor in statistics at Eindhoven, University of Technology.

It is important to test the sensitivity of the outcome in order to determine which parameters should be entered most carefully when using the model for the real life case and to determine whether the model is flawed and has no value. Whenever the model is dependent on one parameter which is hard to estimate the model has limited value.

A sensitivity test looks at the effect of a large change in the input parameters of the model on the output of the model. The output of the model is the relation between adding property derivatives and the risk and return of the investment portfolio. This is not to confuse with scenario testing which are tests where all the input parameters are set so that a certain scenario is simulated. These scenario's are normally extreme circumstances that can occur such as a property market breakdown.

First the methodology will be explained, then the standards, minima and maxima followed by the results and a conclusion.

§ 5.2 Methodology
The methodology is as follows.
1. First the standard value of each parameter is set. This is the value that will be used for other parameters when the tested parameter values will be altered.
2. Then for each parameter that will be tested on sensitivity a maximum and minimum value will be set. These will be set in such a way that they can be compared over different parameters, for example the standard plus X% of the standard as a maximum.
3. For each value of the parameter, with reasonable intervals, the relation between adding PIC’s and the risk and return of the investment portfolio is calculated by calculating the risk and return for each percentage of added PIC’s, within reasonable intervals. These calculations are performed by macro's, these are provided on the CD.
4. The data is graphed and two indicators of the relation are calculated:
   - The correlation of the investigated relations (between adding PIC’s and the risk and return) for various values of the tested parameter.
   - The range of the return and risk indicators for the extreme values of the tested parameter.

The correlation shows whether the kind of relation remains the same. Whenever two relations show no correlation then the relation is completely different. Whenever the correlation is perfect then the magnitude of the relation can differ. For example the following arrays are perfectly correlated but differ in magnitude: (1,3,5,7,5,3)(1,2,3,4,3,2)

In order to describe the magnitude the range is calculated, the range of the highest and lowest value, in this case the ranges are 7-1 = 6 and 4-1 = 3.

First the standards, minima and maxima are determined for the parameters.
§ 5.3 Standards, minima and maxima

The standard values of the parameters are the values that are most likely to occur. They are determined by research and judgmentally. By determining the standard values is assumed that the property portfolio is a Dutch all property portfolio and that the property derivatives are over the Dutch all property market. In order to be able to compare the ranges with each other the minima and maxima are set to plus and minus 200% of the standard.

The table below shows the input parameters.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>standard</th>
<th>minimum</th>
<th>maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return; market income</td>
<td>6.50%</td>
<td>0%</td>
<td>19.50%</td>
</tr>
<tr>
<td>Return; market capital</td>
<td>4.60%</td>
<td>-4.60%</td>
<td>13.80%</td>
</tr>
<tr>
<td>Return; excess alpha</td>
<td>0.20</td>
<td>-0.20</td>
<td>0.60</td>
</tr>
<tr>
<td>Return; excess beta</td>
<td>0</td>
<td>-0.40</td>
<td>0.40</td>
</tr>
<tr>
<td>Return; excess gamma</td>
<td>0</td>
<td>-0.40</td>
<td>0.40</td>
</tr>
<tr>
<td>Costs; investment management costs</td>
<td>0.80%</td>
<td>0%</td>
<td>2.40%</td>
</tr>
<tr>
<td>Costs; acquisition costs</td>
<td>6%</td>
<td>0%</td>
<td>18%</td>
</tr>
<tr>
<td>Costs; selling costs</td>
<td>2%</td>
<td>0%</td>
<td>6%</td>
</tr>
<tr>
<td>Accounting period transaction costs</td>
<td>4 yr</td>
<td>1yr</td>
<td>10yr</td>
</tr>
<tr>
<td>Annual premium of PIC</td>
<td>2%</td>
<td>-2%</td>
<td>6%</td>
</tr>
<tr>
<td>Maturity of PIC</td>
<td>4 yr</td>
<td>1yr</td>
<td>10yr</td>
</tr>
<tr>
<td>Standard deviation market</td>
<td>5%</td>
<td>0%</td>
<td>15%</td>
</tr>
<tr>
<td>Beta of direct property portfolio</td>
<td>0.75</td>
<td>0.25</td>
<td>1</td>
</tr>
<tr>
<td>Number of objects in portfolio</td>
<td>8</td>
<td>1</td>
<td>20</td>
</tr>
</tbody>
</table>

Below will be explained per parameter how the standard, minima and maxima are determined.

§ 5.3.1 Return; market income and capital

The future market income and capital return can be determined by using an ex post examination of the market income and capital return and assume the same performance in the near future. Although history might not repeat itself it is the most reliable and convenient indicator we have right now. Further more existing forecast models prove to be not very accurate (Matysiak et al., 2005).

The Dutch market shows an average income return of 6.5% per annum over the last 11 years. The capital return is on average 4.6% per annum (IPD/ROZ, 2006). These are used as standards. The minima and maxima are set per parameter by adding and subtracting 200% times the standard. However when this is not possible, for instance a negative income return is not possible, 0% is taken as minimum. This to ensure the model will not produce erroneous results.

§ 5.3.2 Return; excess alpha, beta and gamma

These values solely depend on the specific direct property portfolio of the investor, on average there is no out-performance of the market, this is because the average is the market. However we assume that
the investor who uses property derivatives is a professional investor which is assumed to outperform the market.

Whether one outperforms on the alpha, beta or gamma depends on the strategy of the investor. If the strategy is based on stock picking then the alpha will be larger. Whenever the strategy is based on selecting the most profitable markets the beta will be larger. If the strategy is based on improving owned assets the gamma will be larger. It is assumed that the investors' strategy is based on picking the best assets in the market; an alpha strategy. It is set to 0.20 so that the excess performance is about 1%.

§ 5.3.3 Costs; investment management costs, acquisition and selling costs

The investment management costs are quite common for investment funds. Research (Robinson, Palmer, 2005) has shown that on average the annual investment management costs are 0.80%.

The minimum is 0% since it can't be lower and the maximum is the standard plus 200%, 2.40% per annum. The acquisition and selling costs of direct property are the same for all property and depend per country.

In the Netherlands acquisition costs amount up to 6% of the purchase price of property, mainly due to stamp duty. Selling costs amount up to 2% of the selling price. The minima are 0% since this cannot be lower and maxima are the standard plus 200%, is 18% and 6%.

§ 5.3.4 Percentage covered transaction costs, maturity, annual premium PIC.

The percentage of the transaction costs that has to be taken into account in the calculation of the risk and return depends on the decision that has to be supported by the model. See chapter four.

We assume here that the direct property was already in possession and that the investor wants to compare whether selling PIC's is more profitable than not selling PIC's and not altering the portfolio.

We assume that the investor keeps his direct property portfolio for 10 years. This means that the transaction costs that have to be covered are only depending on the maturity of the PIC.

Whenever the maturity is X year, the percentage of transaction costs that has to be covered is the maturity/10 years * 100%. We assume the maturity to be 4 yrs so that 40% of the transaction costs have to be taken into account.

The annual premium of the PIC is dependent on several factors like short term performance expectations of the market. However there is no evidence on the relations and so the premium cannot be constructed for the future.

Thereby the market does not know how to price it so premiums heavily fluctuate apparently at random. That's why we use the average premium that is paid for PIC's in the past. An ex post approach. This premium is around 2% per annum as appeared in the interviews. The minimum and maximum is minus and plus 200% of the standard.

§ 5.3.5 Risk; market risk, beta, number of objects

The best estimate available is the standard deviation of the past, for the Dutch market this is 5%(IVBN, 2004). The minimum and maximum are minus and plus 200% with the minimum set to 0%.

The beta of the portfolio is set to a standard of 0.75. This is done because of the following reasons:

- First of all it is the absolute deviation of the Beta from one that counts, since the Beta in the risk formula is implemented in the following way:

\[(1 - \beta)^2\]
- Research of Byrne and Lee (2001) shows that on average the absolute deviation from the various sectors from Beta to one is 0.15. However these are whole sector portfolio's and thus quite similar to the market which has a Beta of 1.
- This is corrected arbitrarily to 0.25 to account for the fact that the average portfolio will not resemble the market that well as a whole sector.

The minimum is then set to a absolute deviation of 0.25 plus 200% times the absolute deviation is 0.75. This means a Beta of 0.25 or 1.75. The maximum is a absolute deviation of 0, this means a Beta of 1.

The number of assets in the portfolio depends per portfolio. We assume a portfolio of 8 different assets with a minimum of 1 and a maximum of 20.

§ 5.4 Results
Each parameter can have effect on the following relations.
- The relation between selling property derivatives on the portfolio and the return of the total investment portfolio.
- The relation between selling property derivatives on the portfolio and the volatility of the total investment portfolio.

The relation risk – selling property derivatives will not be separately covered because the risk is made up of the components volatility and return (see §3.2.8). So it does not add anything new. Per relation will be shown what the sensitivitiy of the result is for each of the parameters.

§ 5.4.1 Relation selling property derivatives – return
When all the values are the standard values the relation looks as follows when selling PIC's:

![Graph one: the relation between selling PIC's and the return of the investment portfolio with standard input parameters](image1)

When all the values are the standard values the relation looks as follows when swapping the IPD return:

![Graph two: the relation between swapping returns and the return of the investment portfolio with standard input parameters](image2)
Graph one above shows that the modified internal rate of return or the "return" of the investment portfolio increases when selling more PIC's on the portfolio. The relation is expressed and graphed as the extra return with regard to not selling any PIC's. For example when selling 60% of the nominal value of the direct property portfolio as PIC's the return of the total investment portfolio increases with 1% per year. Graph two above shows that the expected modified internal rate of return decreases when swapping the IPO returns for a LIBOR rate. All the parameter values were changed according to the methodology described above.

It appeared that the shape of the line did not alter much by changing the values for the various parameters. The minimum and maximum lines for the market income are drawn below to show, as a typical example that the shape does not change.

If the shape of the line does not alter the correlation between the lines is one. That the relations do not change is shown below in the table where the various correlations of the relations with different values for the parameters are presented.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Standard</td>
</tr>
<tr>
<td>Market income</td>
<td>-1</td>
</tr>
<tr>
<td>Excess alpha</td>
<td>-1</td>
</tr>
<tr>
<td>Excess beta</td>
<td>1</td>
</tr>
<tr>
<td>Excess gamma</td>
<td>1</td>
</tr>
<tr>
<td>Investment costs</td>
<td>1</td>
</tr>
<tr>
<td>Acquisition costs</td>
<td>1</td>
</tr>
<tr>
<td>Premium</td>
<td>-1</td>
</tr>
<tr>
<td>Percentage coverage</td>
<td>-1</td>
</tr>
</tbody>
</table>

All the correlations are 1 or -1. Whenever the correlation is -1, the relation inverses. However the inversed shape remains similar. An example is shown below.

This is the relation of the excess beta performance. It shows that the relation changes when the direct property portfolio outperforms the market more.
Due to underperformance of the direct property portfolio with a excess beta of -0.20 the relation inverses. Instead of a positive effect of selling PIC's on the return of the total investment portfolio there is a negative effect.

Although the relation is inverted the shape remains the same. But we have seen that the magnitude does change. The magnitude per parameter is expressed in the range of returns per % of sold PIC's.

We have chosen to look at the range of returns of the different values when 80% of the value of the direct property portfolio is sold as PIC's. Whenever the range is large the return is sensitive to the parameter. The table below shows the 80% ranges for all the parameters. A complete record of the data is provided on the CD.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Range (standard -100%)</th>
<th>Range (standard +100%)</th>
<th>Range</th>
<th>Relative value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market income</td>
<td>2.76%</td>
<td>2.37%</td>
<td>0.40%</td>
<td>8</td>
</tr>
<tr>
<td>Excess alpha</td>
<td>2.30%</td>
<td>3.75%</td>
<td>1.46%</td>
<td>7</td>
</tr>
<tr>
<td>Excess beta</td>
<td>-0.30%</td>
<td>5.76%</td>
<td>6.06%</td>
<td>2</td>
</tr>
<tr>
<td>Excess gamma</td>
<td>0.90%</td>
<td>4.77%</td>
<td>3.87%</td>
<td>3</td>
</tr>
<tr>
<td>Investment costs</td>
<td>3.37%</td>
<td>1.23%</td>
<td>2.13%</td>
<td>6</td>
</tr>
<tr>
<td>Acquisition costs</td>
<td>3.81%</td>
<td>0.93%</td>
<td>2.87%</td>
<td>5</td>
</tr>
<tr>
<td>Premium</td>
<td>-1.47%</td>
<td>8.10%</td>
<td>9.57%</td>
<td>1</td>
</tr>
<tr>
<td>Percentage coverage</td>
<td>4.12%</td>
<td>0.62%</td>
<td>3.50%</td>
<td>4</td>
</tr>
</tbody>
</table>

The table shows some remarkable results.
The market income is not relevant for the relationship, the PIC premium however is most relevant. Furthermore the excess Beta and gamma are relevant and the percentage coverage have a relatively large effect on the return.

The ranges show that not one parameter does determine the return by its own. The sensitivity is quite well distributed along the parameters. The largest influence is the premium which range is roughly 30% of the total range.

§ 5.4.2 Relation selling property derivatives – standard deviation

When all the values are the standard values the relation for selling PIC's looks as follows:
When all the values are the standard values the relation looks as follows when swapping the IPD return:

The standard deviation of the portfolio increases when selling more PIC's on the portfolio. The relation is expressed as the increased standard deviation with regard to not selling any PIC's. For example when selling 60% of the nominal value of the direct property portfolio as PIC's the standard deviation of the total investment portfolio increases with 0.30%. 

All the parameter values were changed according to the methodology described above. The data are provided on the CD. It appeared that the shape of the line did not alter much by changing the values for the various parameters. All the correlations were one. But that the magnitude does change. The magnitude per parameter is expressed in the range of standard deviation per % of sold PIC's.

We have chosen to look at the range of standard deviations of the different values when 80% of the value of the direct property portfolio is sold as PIC's. Whenever the range is large the return is sensitive to the parameter.

The table below shows the 80% ranges for all the parameters. A complete record of the data is provided on the CD.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Range -100%</th>
<th>Range +100%</th>
<th>Range</th>
<th>Relative value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market standard deviation</td>
<td>1.98%</td>
<td>10.07%</td>
<td>8.10%</td>
<td>2</td>
</tr>
<tr>
<td>Beta</td>
<td>10.20%</td>
<td>1.78%</td>
<td>8.42%</td>
<td>1</td>
</tr>
<tr>
<td>Number of objects</td>
<td>-3.36%</td>
<td>-3.46%</td>
<td>0.10%</td>
<td>3-4</td>
</tr>
<tr>
<td>Constant Q</td>
<td>0.33%</td>
<td>0.43%</td>
<td>0.10%</td>
<td>3-4</td>
</tr>
</tbody>
</table>

The table shows that the Beta is a very important indicator of the risk of the total investment portfolio while the diversification level is only of limited interest, this is remarkable.
The ranges show that not one parameter does determine the return by its own however the Beta is a very important parameter. The ranges are shown below in the graph.

§ 5.5 Conclusions sensitivity test
The conclusions are that the return is not dependent on one parameter but its sensitivity is fairly well distributed over the parameters. Most important is the premium on the PIC and the excess beta performance of the investor.
For the standard deviation the Beta is most important by far, followed by the market standard deviation. The level of diversification is of less importance. However whenever the portfolio is more diversified the Beta might be closer to one. So there might be an indirect diversification effect.
Section C; Chapter six; cases

§ 6.1 Introduction
In this chapter some cases are provided that show how the model can be used to support decisions about property derivatives. These cases are based on real life situations where the model is already used in practice and hypothetical cases that show the wide set of applications for the model.

There is a real life case and a hypothetical case.

- The real life case is a situation where an investor wants to use the PIC’s as a way of financing.
- The hypothetical case is an investor who wants to magnify the returns of his well performing but badly diversified portfolio by the use of selling property derivatives.

For each case the context, the input parameters, the results and the conclusions are discussed.

§ 6.2 Case one; based on a real life situation
§ 6.2.1 Context
The context is as follows. Investor X is an institutional investor located in the Netherlands. He has no direct property at the moment. The investor wants to buy a Dutch direct property portfolio. This property portfolio is diversified over the Dutch market, the investor believes that the portfolio contains the best assets in the market and expects an out performance by the property portfolio.

The reason why the investor wants to sell PIC’s is that he lacks the capital to buy the whole portfolio, he can only afford half of it but does want to buy it now. Especially in the current crowded investment property market. He wants to sell PIC’s in order to gain capital upfront to buy the direct property portfolio. The investor X wants to know what the effect is of selling PIC’s on the investment portfolio. The investment portfolio contains the acquired direct property portfolio and the liabilities of the sold PIC’s. He is especially interested what the effect is when 50% of the value of the direct property portfolio is sold as PIC’s. What is the difference when the portfolio would be bought with equity?

So the model has to show what the effect is of selling 50% of the PIC’s with respect to not selling any PIC’s on the portfolio and buying it with equity. This effect is represented by the change in return, volatility and risk of the portfolio when selling more PIC’s with respect to buying the portfolio with all equity.

First the parameters for the model are determined, then the results are shown and concluded is whether the insights are useful.

§ 6.2.2 Parameters
Market income and capital return.
The PIC’s are based on the Dutch property market and the property portfolio is based in the Netherlands. Investor X had no specific idea about the future market income and capital returns.
Since there is no specific idea about the future performance of the market the best indicator might be the past performance. The same indicator we used when testing on sensitivity.
The past performance of the market is according to the IPD/ROZ over the period 1994-2005 on average an income return of 6.5% and a capital return of 4.6%(IPD/ROZ, 2005).

Excess alpha, beta and gamma return
The strategy of investor X with respect to the direct property portfolio is as follows:
• Only in the Dutch property market is invested.
• The portfolio is diversified over the market.
• The main goal is to select the best objects in the market.

An out performance of the portfolio is expected.

It is unlikely that there will be gamma or beta out performance since no special attention has been given to the asset management and the portfolio is wholly diversified over the Dutch market.

The out performance that is expected is most likely an alpha outperformance, created by picking the best assets which improve most in value. The investor sets the alpha component to 0.20 so that the out performance on capital income is 1%.

Costs; investment management costs, acquisition costs and selling costs
The investment management costs differ per investor, since investor X did not specify it’s investment management costs we could assume that they would equal a normal fund’s investment management costs.

Based on research this is set to 0.80% per annum(Robinson, Palmer, 2005). The acquisition costs and selling costs are dependent in which market the direct property portfolio is bought and sold, in this case it is the Dutch market. The acquisition and selling costs of direct property for the Dutch market are 6% and respectively 2%.

Maturity PIC, percentage coverage transaction costs, reinvestment rate
The reason for selling the PIC’s is that the investor wants to buy the direct property portfolio but does not have the money for it. He expects that in four years he will be able to finance the portfolio with all equity. So the maturity of the PIC is set to four years.

The percentage of transaction costs that had to be covered was not of importance for the decision. This is because the model is used to show the difference between financing the portfolio with all equity or with PIC’s. In both cases investor X has to pay transaction costs. So for the difference it is of zero influence. For the total return and risk of the portfolio it does make a difference. For the difference it does not. Although it makes no difference we have to use some number. In this case we use 0%

The reinvestment rate is set by the investor to 10%, this is based on the average investment rate of the investor.

Premium PIC
The premium differs per situation. It depends on the expected short term market conditions, the transaction costs of direct property and the way of offering them on the market. However as we have seen there are no ways to model the price yet.

The recent experiences of PIC prices in the UK are that 2.75% per annum is paid as a premium. It is acknowledged by market participants that these prices may be irrationally high. Since there is no expected short term down or upturn of the market prices will probably be around the average of the UK market of the past 5 years. This is about 1.75% per annum. But the only way we truly find out what the premium will be is when selling the PIC’s on the Dutch market.

Standard deviation market, Beta of property portfolio and number of objects
The number of objects in the portfolio was easy to determine, this was over 20 objects. The standard deviation of the market in the future however was more difficult to determine.
Since the investor did not have a specific view of the standard deviation we use the same standard deviation as in the tests which is based on an ex post observation of the standard deviation of the Dutch market over the last 11 years. This is 5% (Vastgoedwijzer, 2004).

The Beta of the property portfolio depends per portfolio. Due to the fact that the portfolio is diversified over the Dutch market the Beta will resemble 1. Based on several characteristics of the portfolio like lease lengths and the vacancy rate we estimate the Beta of the portfolio on 0.90.

All the parameters are shown below in the table.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return; market income</td>
<td>6.50%</td>
</tr>
<tr>
<td>Return; market capital</td>
<td>4.60%</td>
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<tr>
<td>Return; excess alpha</td>
<td>0.20</td>
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<tr>
<td>Return; excess beta</td>
<td>0</td>
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<tr>
<td>Return; excess gamma</td>
<td>0</td>
</tr>
<tr>
<td>Costs; investment management costs</td>
<td>0.80%</td>
</tr>
<tr>
<td>Costs; acquisition costs</td>
<td>6%</td>
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<tr>
<td>Costs; selling costs</td>
<td>2%</td>
</tr>
<tr>
<td>Coverage transaction costs</td>
<td>0%</td>
</tr>
<tr>
<td>Annual premium of PIC</td>
<td>1.75%</td>
</tr>
<tr>
<td>Maturity of PIC</td>
<td>4 yr</td>
</tr>
<tr>
<td>Reinvestment rate</td>
<td>10%</td>
</tr>
<tr>
<td>Standard deviation market</td>
<td>5%</td>
</tr>
<tr>
<td>Beta of direct property portfolio</td>
<td>0.9</td>
</tr>
<tr>
<td>Number of objects in portfolio</td>
<td>20</td>
</tr>
</tbody>
</table>

§ 6.2.3 Results

This results in three relations.

- The relation adding PIC's and the return of the investment portfolio.
- The relation adding PIC's and the standard deviation of the investment portfolio.
- The relation adding PIC's and the risk of the investment portfolio, risk expressed as the probability of underperformance.

It would be enough to compare the situation when 50% of the value of the portfolio is sold as PIC's to provide the investor with a valuable insight. However the whole relation is shown because it provides more insight in the working of PIC's.
First the effect on the return and the standard deviation is shown.

The standard deviation and the return of the portfolio increases when selling more PIC's. The return and standard deviation increase quicker when more PIC's are sold.

The effect on the risk of the portfolio is shown below:

Due to the fact that the return is increasing relatively faster than the standard deviation of the investment portfolio the chance that the return will be lower than 5% is decreasing until 78% of the direct property portfolio is sold as PIC's.

Below the main sensitivities of the results will be shown.

Sensitivity different beta's for the relation
§ 6.2.4 Conclusions

The standard deviation and the return both increase when selling more PIC's on the direct property portfolio. However the probability of a return below 5% decreases when selling more PIC's. Whenever the portfolio is bought with 50% of the value sold as PIC's the return and standard deviation increase with respectively 1% and 0.5%. This change does not alter the risk/return characteristics of the investment dramatically. However the investor has to take into account increased sensitivity of the returns to under and outperformance of the direct property portfolio during the maturity of the PIC. Also he has to take into account that the relation changes a lot when the premiums are different than expected.

Whenever the investor thinks of selling even more than 50% as PIC's then 80% of selling PIC's would optimize the ratio return/risk.
§ 6.3 Case two: hypothetical

§ 6.3.1 Context
The context is as follows. Investor Y is an institutional investor located in the Netherlands. He already has a direct property portfolio at the moment. This property portfolio is focused on the Dutch office market. The investor has a special focus on the asset management of the offices and believes that the office market will outperform the Dutch all property market. He plans to keep the portfolio for over 10 years and already has it for 4 years. The portfolio consists of only three large properties. Due to the excellent asset management the portfolio is not sensitive to the market, the vacancy rate is low and the buildings are in good condition.

The reason why the investor wants to sell PIC’s is that he thinks it is a way to improve the risk/return profile of the investment portfolio. He wants to know what the optimal amount of PIC’s is to sell. So the model has to show what the optimal amount of PIC’s is to sell in order to gain the best return/risk profile.

First the parameters for the model are determined, then the results are shown and concluded is whether the insights are useful.

§ 6.3.2 Parameters

Market income and capital return.
The PIC’s are based on the Dutch property market and the property portfolio is based in the Netherlands. Investor Y had the idea that market would not perform that well. They thought that on average the market income would be 5% over the next 4 years and the market capital return would be 4.3%.

Excess alpha, beta and gamma return
The strategy of investor Y with respect to the direct property portfolio is as follows:

- Only in the Dutch office sector is invested.
- The portfolio is thus focused on the office sector, which is expected to outperform the market.
- The main goal is to improve the cash flows from the objects in the portfolio.

Overall the investor expects a large outperformance. This would be due to the fact that the office market performs better than the overall market and the excellent asset management. This means that there is a Beta and Gamma out performance. The investor estimates a Gamma out performance of 20% on the returns of the portfolio. For example instead of 5% a 5%*120% = 6% return. Furthermore is an outperformance of 20% on the Beta component expected.

Costs; investment management costs, acquisition costs and selling costs
The investment management costs differ per investor, the average is, as we saw before, 0.80%. The costs of investor Y are slightly higher due to the fact that the three properties are located far from each other. The annual investment management costs are 1%. The acquisition and selling costs of direct property for the Dutch market are 5% and respectively 2%.

Maturity PIC, percentage coverage transaction costs, reinvestment rate
The reason for selling the PIC's is that the investor wants to improve its risk/return profile of the investment portfolio. The maturity of the PIC will be that maturity which provides the optimal risk/return profile. We start with the maturity of 6 years.

The transaction costs that have to be covered are the percentage time of the property derivatives with regard to the total ownership of the direct property portfolio. For six years this is 6 year/10 year is 60%. For a five year maturity this is 50%. The reinvestment rate is set by the investor to 10%, this is based on the average investment rate of the investor.

**Premium PIC**

The premium differs per situation. It depends on the expected short term market conditions, the transaction costs of direct property and the way of offering them on the market. However as we have seen there are no ways to model the price yet.

The recent experiences of PIC prices in the UK are that 2.75% per annum is paid as a premium. It is acknowledged by market participants that these prices may be irrationally high. Since there is no expected short term down or upturn of the market prices will probably be around the average of the UK market of the past 5 years. This is about 1.75% per annum. But the only way we truly find out what the premium will be is when selling the PIC's on the Dutch market.

**Standard deviation, Beta of property portfolio and number of objects**

The number of objects in the portfolio was easy to determine, three objects. The standard deviation of the market in the future however was more difficult to determine.

Since the investor did not have a specific view of the standard deviation we use the same standard deviation as in the tests which is based on an ex post observation of the standard deviation of the Dutch market over the last 11 years. This is 5% (Vastgoedwijzer, 2004).

The Beta of the property portfolio depends per portfolio. Due to the fact that the portfolio is badly diversified over the Dutch market and it is in a very good condition so that market conditions do not influence the performance the Beta will be relatively low. A Beta of 0.30 is expected.

All the parameters are shown below in the table.

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<tr>
<th>Parameter</th>
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<tbody>
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<td>Return; market income</td>
<td>5.00%</td>
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<tr>
<td>Return; market capital</td>
<td>4.60%</td>
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<td>Return; excess alpha</td>
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<td>Return; excess beta</td>
<td>0.20</td>
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<tr>
<td>Return; excess gamma</td>
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</tr>
<tr>
<td>Costs; investment management costs</td>
<td>1.0%</td>
</tr>
<tr>
<td>Costs; acquisition costs</td>
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</tr>
<tr>
<td>Costs; selling costs</td>
<td>2%</td>
</tr>
<tr>
<td>Coverage transaction costs</td>
<td>60%</td>
</tr>
<tr>
<td>Annual premium of PIC</td>
<td>1.75%</td>
</tr>
<tr>
<td>Maturity of PIC</td>
<td>6 yr</td>
</tr>
<tr>
<td>Standard deviation market</td>
<td>5%</td>
</tr>
<tr>
<td>Beta of direct property portfolio</td>
<td>0.3</td>
</tr>
<tr>
<td>Number of objects in portfolio</td>
<td>3</td>
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</tbody>
</table>
§ 6.3.3 Results
This results in three relations:

- The relation adding PIC's and the return of the investment portfolio.
- The relation adding PIC's and the standard deviation of the investment portfolio.
- The relation adding PIC's and the risk of the investment portfolio, risk expressed as the probability of underperformance.

We are interested in the effect of selling PIC's on the risk/return profile. This is for different maturities with a maximum of a maturity of six years.

First the effect on the return and the standard deviation is shown.

The standard deviation and the return of the portfolio increases when selling more PIC's. The return and standard deviation increase quicker when more PIC's are sold.

The effect on the risk of the portfolio is shown below:

Due to the fact that the standard deviation is increasing relatively faster than the return of the investment portfolio the chance that the return will be lower than 5% is increasing with a faster slope when more of
the direct property portfolio is sold as PIC's. The fact that it is increasing is probably due to the fact that the portfolio is badly diversified and has a low Beta.

Below the main sensitivities of the results will be shown. Sensitivity different out performance beta's for the relation:

Graph 14; Sensitivity of the return to the Excess beta out performance of the direct property portfolio

Effect of different premiums on the ratio return/risk:

Graph 15; Sensitivity of the ratio return/risk to the premium of the PIC.

§ 6.3.4 Conclusions
The standard deviation and the return both increase when selling more PIC's on the direct property portfolio. However the probability of a return below 5% increases when selling more PIC's. This is due to
the fact that the portfolio is insensitive to market movements and is undiversified. So it has a low beta and a low n, the basis risk will be high.

An improvement of the ratio return/risk while selling more PIC’s depends on the premium. With an expected premium of 1.75% per annum, as expected by the investor, the ration only improves after selling more than 80% of his portfolio as PIC’s.

§ 6.4 Case three; hypothetical

§ 6.4.1 Context
The context is as follows. Investor Z is an institutional investor located in the Netherlands. He already has a direct property portfolio at the moment. This property portfolio is focused on the Dutch market. He plans to keep the portfolio for over 10 years and already has it for 2 years. The portfolio is well diversified and consists of over 20 properties. The investor does not expect any out performance of the market of his direct property portfolio.

The reason why the investor wants to swap IPD returns for the LIBOR rate is that he expects a downturn in the Dutch all property market. However after 5 years he expects an upturn and he would like to keep his direct property to profit from this upturn. He wants to know what the risk return profile is for various percentages of swapped IPD returns of the investment portfolio. So the model has to show what the effect is of swapping IPD returns.

First the parameters for the model are determined, then the results are shown and concluded is whether the insights are useful.

§ 6.4.2 Parameters
Market income and capital return.
The swap is based on the Dutch property market and the property portfolio is based in the Netherlands. Investor Z had the idea that market would not perform that well.

They thought that on average the market income would be 5% over the next 4 years and the market capital return would be 4%.

Excess alpha, beta and gamma return
It is not expected that the direct property portfolio will out or underperform to the market.

Costs: investment management costs, acquisition costs and selling costs
The investment management costs differ per investor, the average is, as has been seen before, 0.80%, which will be used in this case. The acquisition and selling costs of direct property for the Dutch market are 6% and respectively 2%.

Maturity PIC, percentage coverage transaction costs, reinvestment rate
The reason for swapping the IPD returns is that the investor wants to hedge it’s portfolio to an expected downturn in the property market. The maturity of the swap will be as long as the expected downturn in the market, which is 5 years.

The transaction costs that have to be covered are the percentage time of the property derivatives with regard to the total ownership of the direct property portfolio. For a five year maturity this is 50%. The
reinvestment rate is set by the investor to 10%, this is based on the average investment rate of the investor.

**Premium swap**

The premium differs per situation. It depends on the expected short term market conditions, the transaction costs of direct property and the way of offering them on the market. However as has been seen before, there are no ways to model the price yet.

The recent experiences of swap prices in the UK are that 2.75% per annum is paid as a premium. It is acknowledged by market participants that these prices may be irrationally high. Since there is no expected short term down or upturn of the market prices will probably be around the average of the UK market of the past 5 years. This is about 1.75% per annum. But the only way we truly find out what the premium will be is when swapping on the Dutch market.

**Standard deviation market, Beta of property portfolio and number of objects**

Since the investor did not have a specific view of the standard deviation, the same standard deviation as in the tests is used, which is based on an ex post observation of the standard deviation of the Dutch market over the last 11 years. This is a standard deviation of 5% (Vastgoedwijzer, 2004).

The Beta of the property portfolio depends per portfolio. Due to the fact that the portfolio is well diversified over the Dutch market and it is in a normal condition so that market conditions do not influence the performance the Beta will be relatively close to one. A Beta of 0.90 is expected.

All the parameters are shown below in the table.

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<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Return; market income</td>
<td>5.00%</td>
</tr>
<tr>
<td>Return; market capital</td>
<td>4.00%</td>
</tr>
<tr>
<td>Return; excess alpha</td>
<td>0</td>
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<tr>
<td>Return; excess beta</td>
<td>0</td>
</tr>
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<td>Return; excess gamma</td>
<td>0</td>
</tr>
<tr>
<td>Costs; investment management costs</td>
<td>0.80%</td>
</tr>
<tr>
<td>Costs; acquisition costs</td>
<td>6%</td>
</tr>
<tr>
<td>Costs; selling costs</td>
<td>2%</td>
</tr>
<tr>
<td>Coverage transaction costs</td>
<td>50%</td>
</tr>
<tr>
<td>Annual premium of swap</td>
<td>1.75%</td>
</tr>
<tr>
<td>Maturity of swap</td>
<td>5 yr</td>
</tr>
<tr>
<td>Annual LIBOR rate</td>
<td>4%</td>
</tr>
<tr>
<td>Standard deviation market</td>
<td>5%</td>
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<tr>
<td>Beta of direct property portfolio</td>
<td>0.9</td>
</tr>
<tr>
<td>Number of objects in portfolio</td>
<td>20</td>
</tr>
</tbody>
</table>

§ 6.4.3 Results

This results in three relations.

- The relation swapping more IPD returns and the return of the investment portfolio.
- The relation swapping more IPD returns and the standard deviation of the investment portfolio.
- The relation swapping more IPD returns and the risk of the investment portfolio, risk expressed as the probability of underperformance.
We are interested in the risk/return profile of the investment portfolio after swapping the IPD returns for a LIBOR rate for a certain percentage of the nominal amount of the direct property portfolio. First the effect on the return and the standard deviation is shown.

**Graph 16; the standard deviation and the return for various levels of swapped IPD returns.**

The standard deviation and the return of the portfolio decreases when swapping more IPD returns. The standard deviation and return decrease with a steady rate.

The effect on the risk of the portfolio is shown below:

**Graph 17; the risk when swapping more IPD returns**

Due to the fact that the standard deviation is decreasing relatively faster than the return of the investment portfolio the chance that the return will be lower than 5% is decreasing with a faster slope when more of the direct property portfolio is swapped for a LIBOR rate. Below the main sensitivities of the results will be shown. Sensitivity different out performance beta's for the relation.
§ 6.3.4 Conclusions
The standard deviation and the return both decrease when swapping more on the direct property portfolio. However the probability of a return below 5% decreases when swapping more IPD returns.

§ 6.5 Conclusions
The cases show that the model can be used to support investors by making their decisions. The model does this by providing the insights into the developments of the risk and return of the investment portfolio when selling more PIC’s or swapping more IPD returns. Shown is that the return and risk when swapping is different than when selling PIC’s. In a nutshell: selling PIC’s increases the return and risk of the investment significantly, it creates an investment highly sensitive for out and underperformance and the premium of the PIC. Swapping IPD returns creates a total different kind of investment portfolio. It decreases the risk and return of the investment portfolio so that it looks more like a safer investment like bonds and obligations.
Section D; chapter seven; Conclusion

This chapter concludes the report. In this chapter the main results will be discussed, the study evaluated and recommendations for further research will be provided.

§ 7.1 Main results of the study

In this paragraph the main results of the study will be discussed. Each result is briefly explained. All the results together briefly summarize the study.

The risk is best characterized by the following two indicators;
- the probability that the return is below the threshold value and
- the volatility of the investment portfolio.

Both the probability of underperformance and the volatility have to be calculated by the model in order to provide the most accurate view on the risk. The probability alone is not enough since a very high return can camouflage a high volatility since the probability is dependent on the volatility and return of the investment portfolio.

The standard deviation of the Investment portfolio and the probability of underperformance are broken down into the following components:

![Figure 13: the determinants of the risk](image)

These components were tracked by reviewing the literature and interviewing professionals. How it is statistically correctly calculated is shown below.

The standard deviation of the investment portfolio is calculated by:

$$\sqrt{(x_m^2 + x_{pd}^2 + 2x_m x_{pd} \sigma_m^2 + x_m^2 (\beta - 1)^2 + (B/n)^2)}$$

Where:

$x_m$ = weight of the direct property portfolio
\[ x_{\text{wd}} = \text{weight of the property derivatives} \]
\[ \sigma_{\text{m}}^2 = \text{Variance of the property market} \]
\[ \beta_i = \text{Beta of the direct property portfolio} \]
\[ Q = \text{Constant Q} \]
\[ n = \text{Number of objects in the portfolio} \]
\[ X_{\text{inv}} = \text{Amount of capital invested} \]

The return is best calculated by the modified internal rate of return.

The return can best be calculated by the modified internal rate of return because it does not assume, like the Internal Rate of Return, that the capital gained can be reinvested at the same rate. With the modified rate of return it is possible that the reinvestment rate can be separately specified. Furthermore the Net Present Value heavily depends on the discount rate, this discount rate depends on the risk but cannot be accurately specified. Besides that it is a performance measurement which already takes into account the risk when calculating the return. In this study we want to view the impact on the return and the risk separately. The modified internal rate of return is calculated over the annual net cash flows.

The following main cash flows determine the modified internal rate of return:

![Figure 14: the determinants of the return](image)

Figure 14 shows the cash flows that make up the modified internal rate of return.

The model is correctly calculated and is not dependent on one input parameter.

The model is tested by Prof. Dr. Van Berkum, a professor in statistics. The model is now completely without errors and the risk and return are correctly calculated. The ranges of the output parameter do vary when different parameter values are altered. However there is no single parameter that determines the return or standard deviation. The most determining return parameter is the premium and the most determining parameter for the standard deviation is the Beta of the direct property portfolio.

The return and standard deviation of the investment portfolio with standard input parameter values increases when adding PIC's. The risk shows an optimum

In a typical situation the return and the standard deviation of the investment portfolio will increase when selling a larger amount of PIC's. The more PIC's are sold the faster it increases. When many PIC's are
sold the investment portfolio becomes highly sensitive to out and underperformance of the direct property portfolio.

The return and volatility of the investment portfolio with standard input parameters decreases when swapping IPD returns.

In a typical situation the return and standard deviation of the investment portfolio does decrease when swapping more IPD returns. It is shown that when swapping more IPD returns for a LIBOR rate the chance of having a return below 5% can decrease to almost zero. Interestingly see is that when the portfolio is badly diversified and has a high tracking error risk the probability of under performance does not decrease to zero but remains somewhat similar when swapping more IPD returns.

§ 7.2 Evaluation of the study

In this paragraph we will evaluate the study, whether the goal is met, the research question answered and whether the model is reliable and calculated correctly.

The research question was:

"What are the implications of selling property derivatives for the risk and return of the seller of risk’s investment portfolio?"

The study provided an answer on the research question by showing the implications by the use of a calculation model. The model is based on an extensive literature review and interviews with property professionals. The characteristics of the direct property portfolio and the property derivatives are specified by 19 input parameters. In this way it is possible to calculate for a wide spectrum of different portfolio’s the relation between selling property derivatives and the risk and return of the investment portfolio.

The goal of the study was:

"To get insight into the implications of selling property derivatives on the risk and return of the portfolio of the seller in order to support them making their decision, increase transparency and increase liquidity and the development of the market."

Since it is possible to get insight into the implications of selling property derivatives for many specific cases the goal is met. With this study and calculation model property investors can see the effect of selling property derivatives on the risk and return of their investment portfolio. The study has practical relevance, the model developed for this study already has been used in practice several times and proved its value. Furthermore does the study have academic relevance since it is the first time that the impact of property derivatives on the risk and return of the investment portfolio is modelled.

The model is based on the literature and interviews and provides a decent calculation of the return and risk. However it can best be used to gain insights into the implications and can best be interpreted as an indication. For professional investors the model is probably not accurate enough, this was also never the intention, the model is designed for providing insights into the implications of selling property derivatives.

This study, and the model, is the first quantitative approach to estimating the risk and return of an investment portfolio containing property derivatives. It’s unique in its approach, but this does not mean
that it is a complete approach. There can be enough additional research be done to further elaborate on the risk and return and get a more complete and precise view.

§ 7.3 Recommendations for further research
The study offers various possibilities for further research. They are mentioned below:

- The model can be expanded by taking into account more different kinds of property derivatives, in this model only the most used property derivatives in 2006 are taken into account, which are Total Return Swaps and Property Index Certificates.
- The model can be expanded by taking into account more different investment portfolios. For example the effect of property derivatives on an investment portfolio with indirect property can be modelled.
- The input parameters can be decomposed further:
  - The premium of property derivatives is in this report an input parameter, this premium can be decomposed in several components like the short term market performance expectation and the transaction costs of property.
  - The Beta of the direct property portfolio can be modelled in further research.
  - The level of diversification can be estimated more accurately with further research, it is in this report determined by the number of assets in a portfolio while it is known that it also depends on the sector and location of an asset. However there are till now no quantitative relations known.
  - The constant Q can be determined more accurately, the model now uses a constant Q based on UK data. Further research can determine the constant Q with Dutch data.

After all this study will show some interesting insights in the mechanics of property derivatives but hopefully it will also trigger more quantitative research on property derivatives.
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Appendix A; Glossary

Property derivatives:
Financial instruments whose value depends on the values of other, more basic, property related, underlying variables.

Investment portfolio:
The portfolio of investment assets

Seller of risk:
The party that provides the property return for a premium.

Element:
The risk or return is made up of several elements, these elements can be divided into more elements.

Indicator:
The indicator is the expression for the risk or return.

Free float:
Free float is the amount of shares that is kept by shareholders who are potentially willing to trade. The free float amount of shares of a company can be substantially smaller than the total amount of shares available due to shareholders who will not trade, like the founder of the company.

London FOX debacle:
The London Fox Exchange was a property derivatives exchange initiative in 1994 which failed due to lack of liquidity and supposed insider knowledge.

Smoothing:
Smoothing is the underestimation of volatility by valuers of property due to adapting valuations to previous valuations.

Eurobond:
A bond is a security that pays of interest to the holder, a Eurobond is a bond which is issued across the national border of the institution in another currency.
Appendix B: Portfolio theory

The basis of the portfolio theory is based on the idea that diversification reduces risk. Harry Markowitz laid the foundation for portfolio theory. This was the beginning of the “Capital Market Theory”. According to this theory one could determine its asset allocation by using the expected return, variance and covariance of each asset.

“Although portfolio theory and its subsequent development into the capital asset pricing model have focused on equity shares the theory has a general application and can be applied to all risky assets.” (Brown and Matsiak, 2001)

The diversification effect is characterized by the following old investors wisdom: “Don’t put all your eggs in the same basket.” Assets which are less than perfectly correlated will flatten out each other positive and negative extremes. For example two assets have a negative correlation. When one asset performs very well the other will perform less and vice versa. In this way the total risk of the portfolio, measured as the standard deviation of the returns around the mean, will decrease due to the diversification effect.

The diversification effect can be shown mathematically as follows:

\[ \sigma_p^2 = \sum_{i=1}^{n} x_i^2 \sigma_i^2 + \sum_{i=1}^{n} \sum_{j=1}^{n} x_i x_j \sigma_{ij} \]

where:
- \( \sigma_i \): standard deviation of asset \( i \).
- \( \sigma_p \): standard deviation of portfolio
- \( \sigma_{ij} \): covariance of returns between \( i \)th and \( j \)th asset.
- \( x_i \): weight of asset \( i \)
- \( n \): number of assets

For example when a portfolio consists of two assets with the following returns:

Table from Brown and Matysiak (2003)

<table>
<thead>
<tr>
<th>Years</th>
<th>A</th>
<th>B</th>
<th>Portfolio</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.00%</td>
<td>8.00%</td>
<td>4.00%</td>
</tr>
<tr>
<td>2</td>
<td>4.00%</td>
<td>5.00%</td>
<td>4.50%</td>
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<tr>
<td>3</td>
<td>8.00%</td>
<td>4.00%</td>
<td>6.00%</td>
</tr>
<tr>
<td>4</td>
<td>2.00%</td>
<td>10.00%</td>
<td>6.00%</td>
</tr>
<tr>
<td>5</td>
<td>-1.00%</td>
<td>8.00%</td>
<td>3.50%</td>
</tr>
<tr>
<td>6</td>
<td>-10.00%</td>
<td>6.00%</td>
<td>-2.00%</td>
</tr>
<tr>
<td>7</td>
<td>-9.00%</td>
<td>9.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>8</td>
<td>-6.00%</td>
<td>8.00%</td>
<td>1.00%</td>
</tr>
<tr>
<td>9</td>
<td>0.00%</td>
<td>3.00%</td>
<td>1.50%</td>
</tr>
<tr>
<td>10</td>
<td>2.00%</td>
<td>-8.00%</td>
<td>-3.00%</td>
</tr>
<tr>
<td>11</td>
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<td>2.00%</td>
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</tr>
<tr>
<td>12</td>
<td>10.00%</td>
<td>-2.00%</td>
<td>4.00%</td>
</tr>
<tr>
<td>13</td>
<td>4.00%</td>
<td>-2.00%</td>
<td>1.00%</td>
</tr>
<tr>
<td></td>
<td>8.00%</td>
<td>-8.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>------</td>
<td>-------</td>
<td>--------</td>
<td>-------</td>
</tr>
<tr>
<td>Average</td>
<td>0.71%</td>
<td>3.07%</td>
<td>1.89%</td>
</tr>
<tr>
<td>Standard dev.</td>
<td>6.09%</td>
<td>5.99%</td>
<td>2.82%</td>
</tr>
<tr>
<td>Correlation A,B</td>
<td>-0.56</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In words it has the following logic: The risk of a portfolio containing two assets decreases when the correlation between those two assets decreases. Because when one asset performs less than expected.
Appendix C; Formulas

Overview of the formulas used in this study:

Lower partial moment (LPM)

\[ LPM = \sqrt[\nu]{\frac{1}{T} \cdot \sum_{i=1}^{T} (r_i - \bar{r})^\nu} \]

Where:

- \( LPM \) = Lower partial moment
- \( T \) = number of observations
- \( r_i \) = return at time i.
- \( N \) = power
- \( \bar{r} \) = average returns over certain past period

Mean Absolute Deviation (MAD)

\[ MAD = \frac{1}{T} \sum_{t=1}^{T} |R_t - E(R)| \]

Where:

- \( MAD \) = Mean Absolute Deviation
- \( T \) = Time till maturity
- \( R_t \) = Return at time t
- \( E(R) \) = Expected return

Standard deviation (SD)

\[ \sigma = \sqrt{\frac{1}{n} \cdot \sum_{i=1}^{n} (r_i - \bar{r})^2} \]

Where:

- \( \sigma \) = standard deviation
- \( n \) = number of observations
- \( r_i \) = return at time i.
- \( \bar{r} \) = average returns over certain past period
Risk

Probability

\[ Z = \frac{R_t - E(r)}{\sigma} \]

where:

- \( R_t \) = the threshold return
- \( Z \) = probability for a normal distribution with mean 0 and a standard deviation of 1.
- \( \sigma \) = Standard deviation
- \( E(r) \) = Expected return

Absolute Standard deviation

\[
\sqrt{\left(x_m^2 + x_{pd}^2 + 2x_m x_{pd}\right)\sigma_m^2 + x_m^2(\sigma_m^2 \cdot (\beta_i - 1)^2 + (B/n)^2)}
\]

where:

- \( x_m \) = weight of the direct property portfolio
- \( x_{pd} \) = weight of the property derivatives
- \( \sigma_m^2 \) = Variance of the property market
- \( \beta_i \) = Beta of the direct property portfolio
- \( B \) = Constant B
- \( n \) = Number of objects in the portfolio
- \( X_{inv} \) = Amount of capital invested

Relative standard deviation:

\[
\sigma_{ip}^2 = (x_m^2 + x_{pd}^2 + 2x_m x_{pd})\sigma_m^2 + x_m^2(\sigma_m^2 \cdot (\beta_i - 1)^2 + (B/n)^2)
\]

\[
\sigma_{ip}^2 = x_m^2\sigma_m^2 + x_{pd}^2\sigma_{pd}^2 + 2x_m x_{pd}\sigma_m\sigma_{pd}\sigma_{pd}
\]

\[
\sigma_{re}^2 = x_m^2\sigma_m^2 + x_{pd}^2\sigma_{pd}^2 + 2x_m x_{pd}\sigma_m\sigma_{pd}\sigma_{pd}
\]

\[
\sigma_{ip}^2 = x_m^2\sigma_m^2 + x_{pd}^2\sigma_{pd}^2 + 2x_m x_{pd}\sigma_m\sigma_{pd}\sigma_{pd} + 2x_m x_{pd}\sigma_m\sigma_{pd}\sigma_{pd} + 2x_{pd} x_{pd}\sigma_{pd}\sigma_{pd}
\]

\[
\sigma_{re}^2 = \sigma_m^2 \cdot (\beta_i - 1)^2 + \sigma_{mre}
\]
\[ \sigma_{\text{new}}^2 = B(\frac{1}{n}) \]

\[ x_m = x_{sr} \]

\[ \sigma_{\text{pd}}^2 = \sigma_m^2 \]

\[ \sigma_{\text{ip}}^2 = (x_m^2 + \sigma_{\text{pd}}^2) \sigma_m^2 + 2x_m \sigma_{\text{pd}} \sigma_m^2 + 2x_m x_p \sigma_m \sigma_u \sigma_{\text{mar}} + 2x_p x_u \sigma_m \sigma_u \sigma_{\text{mar}} \]

\[ \sigma_{\text{ip}}^2 = (x_m^2 + \sigma_{\text{pd}}^2 + 2x_m x_p) \sigma_m^2 + x_m^2 \sigma_{\text{sr}}^2 \]

**Return**

Cash flow scheme for determining return:

Net present value:

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income return</td>
<td></td>
<td>( R_i )</td>
<td>( R_i )</td>
<td>( R_i )</td>
<td>( R_i )</td>
</tr>
<tr>
<td>Capital return</td>
<td></td>
<td>( R_c )</td>
<td>( R_c )</td>
<td>( R_c )</td>
<td>( R_c )</td>
</tr>
<tr>
<td>Inv.man costs</td>
<td>( C_{\text{inv}} )</td>
<td>( C_{\text{inv}} )</td>
<td>( C_{\text{inv}} )</td>
<td>( C_{\text{inv}} )</td>
<td></td>
</tr>
<tr>
<td>Acquisition costs</td>
<td></td>
<td>( \text{Premium} )</td>
<td>( \text{Nominal amount received} )</td>
<td>( \text{Net cash flows} )</td>
<td>( A_{\text{inv}} )</td>
</tr>
</tbody>
</table>

\[ NPV = \sum_{i=1}^{n} \frac{C_i}{(1+r)^i} \]

Internal rate of return:

\[ \sum_{i=1}^{n} \frac{C_i}{(1 + IRR)^i} \]

Modified internal rate of return:
\[
MIRR = \left( \frac{NPV(\text{reinvestment rate, positive values}) \times (1 + \text{reinvestment rate})^n}{NPV(\text{financerate, negative values}) \times (1 + \text{financerate})} \right)^{\frac{1}{n-1}} - 1
\]

Income return:
\[R_i = r_i \times \text{Nom}_{\text{prop}}; \quad r_i = mr_i + er_i; \quad er_i = mr_i + (\kappa + \gamma) \times mr_i\]

Where:
- \( r_i \) = income return
- \( mr_i \) = market income return
- \( er_i \) = excess income return
- \( \kappa \) = market component excess return (Excess beta)
- \( \gamma \) = excess gamma, improvement component
- \( \text{Nom}_{\text{prop}} \) = Nominal amount of direct property portfolio

Capital return:
\[R_c = r_c \times \text{Nom}_{\text{prop}}; \quad r_c = (\ln(\text{mc} + er_c) \times T) \times (1 - c_{\text{sell}}); \quad er_c = mr_c + (\kappa + \alpha) \times mr_c\]

Liabilities:
\[L_i = l_i \times \text{Nom}_{\text{PD}}\]
\[L_c = l_c \times \text{Nom}_{\text{PD}}\]

The following parameters are all expressed as a percentage
- \( mc \) = market capital return
- \( er_c \) = excess capital return
- \( r_c \) = Capital return
- \( \alpha \) = excess alpha, selection component
- \( c_{\text{inv}} \) = Investment management costs
- \( c_{\text{acq}} \) = Acquisition costs
- \( c_{\text{sell}} \) = Selling costs
- \( l_i \) = Income liability property derivative
- \( l_c \) = Capital liability property derivative
- \( P_{\text{pic}} \) = Premium PIC
- \( P_{\text{swap}} \) = Premium total return swap
$Nom_{PD}$ = Nominal amount of a Total Return Swap or PIC =

$\%_{PD}$ = Percentage of nominal amount of direct property portfolio that is sold as property derivatives.

$NCW$ = Net cash flow

$A_{inv}$ = Amount invested

$NCW = (r_i + r_c - c_{inv}) \times Nom_{prop} + (P_{swap} - l_i - l_c) \times Nom_{pd}$

$r_i = mr_i + er_i$

$R_i = r_i \times Nom_{prop}$

$R_c = r_c \times Nom_{prop}$

$l_i = mr_i$

$l_c = mr_c$

$L_i = l_i \times Nom_{pd}$

$L_c = l_c \times Nom_{pd}$

$A_{inv} = Nom_{prop} \times (1 + c_{acq}) - Nom_{PD} \times (1 + P_{PIC})$