Liquidity risk in real estate investments
from a perspective of institutional investors

MARIA HÄGGBOM
KARIN ÅSENIUS
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by

Maria Häggbom
Karin Åsenius
Likviditetsrisk i fastighetsinvesteringar från institutionella investerares perspektiv

av

Maria Häggbom
Karin Åsenius
Abstract

Over the last couple of years interest rates have decreased. This has led institutional investors to search for alternative assets which generate return. One of the assets which has gained attention in the light of this change is real estate. Historically real estate has presented a high risk adjusted return and since 2006 house prices in Sweden has increased by a total of 56% [Carlgren, 2016]. Real estate is an illiquid asset and it can take time to sell a real estate asset at a price agreed on by both parts. In this study the implications for institutional investors of including or increasing the allocation towards illiquid assets are investigated from a portfolio perspective. In addition, other risk factors relevant to real estate investments are examined together with how the specific liquidity risks can be identified and measured.

The research is divided into two parts. One qualitative part consisting of interviews with investors of Swedish pension funds to understand their view on real estate investments. The other part is quantitative and consists of different ways to model and calculate risks associated with liquidity. The modeling includes ex-ante variance scaling, de-smoothing, scenarios of forced sales and liquidation premium.

The results show that the interview participants' perception of liquidity risk is larger than that obtained through quantitative risk measures. The outstanding performance of real estate seen in indexes may rather be an effect of artificial smoothing\(^1\) rather than the performance in the asset class. A scenario which could impact the investors with regards to illiquid assets is the risk of forced sale. However the situation with strong balance sheets for many of the Swedish institutional investors decrease this risk. The total portfolio risk from illiquid assets are also limited as an effect of the limited allocation to these asset classes.

Key-words Real estate, Institutional investors, Measuring risk, Illiquidity

\(^1\) Artificial smoothing - Smoothing of peak and low historical transaction value due to inherent limitations in the valuation process
Sammanfattning


Studien är uppdelad i två delar. En kvalitativ del bestående av intervjuer med investerare i svenska pensionsfonder för att få en förståelse för deras syn på fastighetsinvesteringar. Den andra, kvantitativa delen, består av olika metoder för att modellera och beräkna risker som kan associeras med likviditet. Modelleringen inkluderar ex-ante varians skalning, de-smoothing, scenarioanalys vid tvingad försäljning och likvideringspremie.


Nyckelord Fastigheter, Institutionella investerare, Risk mått, Illikviditet

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2 Artificiell smoothing – Utjämning av toppar och dalar i historiska transaktionspriser till följd av begränsningar inbyggda i värderingsprocessen
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Definitions

**Asset portfolio** - The combination of financial assets an investor holds. The term portfolio often refers to asset portfolio

**Basis points** - Unit often used for transaction fees of financial assets. One Basis point is $1/100^{th}$ of a percent

**Bid-ask spread** - The gap between the price asked by the seller and the price offered by a buyer

**Correlation** - Statistical relationship between variables

**Differentiation** - For an asset portfolio: finding assets with other characteristics to decrease the total risk

**Efficient frontier** - All allowed combinations of assets that offer the highest expected return for a specific risk level

**Ex-ante** - Based on forecast, outcome unknown at present time

**Ex-post** - Based on outcome rather as opposed to forecast

**Illiquidity** - An asset which takes time to sell to an acceptable price, this can be caused by a limited market

**Institutional investor** - A professional investor making investments for other people or foundations

**Large cap stocks** - The stocks with the highest market capitalization on the market. In Sweden often referred to as the stocks included in the index OMXS30

**Leverage** - The investors return based on the movement in the underlying asset, the effect of leverage can for example be measured from the degree of loans used to finance

**Liquidity** - The degree to which an assets can be bought or sold quickly on the market to an acceptable price

**Market risk** - The risk of a general fall in the market, which cannot be diversified against

**Mean** - The expected value or the average value

**Recession** - Bad market conditions, usually associated with high unemployment and higher numbers of defaults

**Risk free interest rate** - A theoretical rate of return offered for an asset without possibility of loss

**Solvency** - A company’s ability to meet its long-term obligations, often measured as the percentage of assets in relation to liabilities discounted to today's value

**Standard deviation** - Statistical measure for how values of a certain distribution deviate from the average value

**Tail risk** - Events that have a low probability of occurring and results in unusual events, usually seen as the ends of the normal distribution

**Trading volume** - The total number of a specific assets traded under a specific period of time

**Volatility** - The variation in price, measured by standard deviation

**Variance** - The squared standard deviation
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Maria Häggbom and Karin Åsenius
1 Introduction

In this section the background to institutional investors interest in real estate is described leading in to the subject of liquidity. This is followed by the problematization, after which the purpose of the study and the research questions are presented.

1.1 Background

Real estate and property investments have historically given high returns and is considered an attractive and stable investment [Kaplan, 2012]. The Swedish residential real estate market has during the last couple of years been driven by low interest rates and a high demand in relation to the supply in urban areas. Housing prices have increased by 56% in Sweden between 2006 and 2016 in real terms i.e. prices adjusted for inflation [Carlgren, 2016]. This can be compared to the Swedish stock market index OMXS30 which in the last ten years has increased in value by 32% [Avanza, n.d.]. Looking thirty years back the increase in housing prices has been 226% [Carlgren, 2016]. From the graph it is seen that single family homes in Sweden has, since 2005, shown about the same increase as OMXS30, but with lower volatility. Over the same time period the Stockholm Benchmark Index (SBX-Index) has increased more in value as can be seen from the dark blue line in the figure below.

![Figure 1: Nominal return for stocks and single family homes since 2005](Source: Bloomberg and Nasdaq OMX Valueguard-KTH Housing Index)

The high returns real estate investments have given in the past, have resulted in the assets class gaining an increased level of attention from institutional investors, as they hope to benefit from the returns. Many real estate companies are today owned by pension funds, as an example AMF-pension and Fjärde AP-fonden (AP4) together own Rikshem [Ivarsson, 2015]. AMF-pension also has their own real estate company; AMF-fastigheter [SvD, 2015]. The Swedish AP-funds each own one quarter of Vasakronan to give another example of real estate owned by institutional investors [Skogestig, 2017].
For some investors there have been an increased allocation to real estate the last few years, and the increase have been rapid. For example AMF-pensions has quadrupled their holding in residential real estate over the last four years and estimate that their holdings in real estate will double within the next couple of years. Part of this increase took place in 2015 when AMF bought a portfolio of commercial real estate for a value of 6.1 billion SEK [SvD, 2015]. The institutional investors mainly seek real estate investments in areas with high population-growth, for example Stockholm [Ivarsson, 2015]. The trend has shifted over time and a trend seen in the past was that Swedish rental apartments were converted to condominiums and sold off, rather than entire complexes sold to other large investors [Ivarsson, 2015].

For institutional investors, investing pension savings, it is crucial to have a solid foundation of low risk assets. These assets can be used to hedge future liabilities. The most commonly used asset class for hedging have traditionally been high rated bonds [Anson et al., 2011]. The change in interest rates, with decreasing return on all durations and with the bonds with the shortest duration even having negative yield has led to investors searching for alternative investments that have higher return to complement the bonds [Fransson, 2017].

These alternative investments often have a lower level of liquidity, which means that the asset takes longer time to sell [Amihud & Mendelson, 1986] to an acceptable price [Damodaran, 2005]. Despite this fact, alternative invest have grown in popularity as interest rates have fallen. The trend has been that investors have increased their allocation in most types of illiquid assets, the largest and most heavily invested type of real, illiquid investment has however been real estate and other types of property [Anveden, 2017]. However, having only small amount invested in any asset class is a good diversification and can reduce the risk of the overall portfolio. It is when a larger proportion of the total portfolio consists of illiquid assets that the risks may gain importance. [Anson et al., 2011]

1.2 Problematization
As investors wish to increase their allocation towards real estate, the behavior of this asset class gains importance for the overall portfolio performance. The issues of holding real estate and other illiquid assets became apparent during the 2008 financial crisis when liquidity became an issue for investors, not only asset value. During the crisis there were companies which defaulted even though they had assets on their balance sheet. The investors were simply unable to find buyers for their assets. This meant that the assets became worthless. However; if there would have been time to find a buyer, they would have had an economic value [Brunnermeier, 2009]. To accept the liquidity risk the asset owner must be compensated for the risk. The question is at what level, as the risk is almost only present during times of crisis, when the market liquidity is the lowest and the need for cash largest [Aug, 2014].

To see the effects of crisis in Sweden the situation in the beginning of the 1990’s can be examined. This crisis affected the Swedish real estate market and in Stockholm, in 1991, house prices fell with 35% followed by a decrease of 15% in 1992. This crisis affected the Swedish banks and these encountered solvency problems and needed capital to pay liabilities. This froze the market and few objects were traded [Englund, 1999].
The risk of not being able to trade assets or it taking long time to do so, can cause problems. Periods of few or no trades are not seen in indexes and these therefore creates difficulties in determining the true volatility of the asset. In the investment spectrum of real estate and other illiquid assets, an asset only has a value at the time of the transaction. At other times, when there are neither sellers nor buyers in the market the asset has no tangible value. This leads to the effect that most indexes and other sources of continuous valuations are forced to interpolate between values of similar assets and times which in turn may lead to the volatility being artificially low [Edelstein & Quan, 2006].

If institutional investors are to increase their allocation towards illiquid assets, it is important to understand what return that can be expect for a certain level of risk and liquidity. Another issue when shifting towards more illiquid investments is that this may change the risk characteristics of portfolios; from a purely volatility based portfolio risk to a portfolio with several risk factors. As most institutional investors are subject to control of the Swedish FSA, known as Finansinspektionen (FI). They need to be able to report predicted risk and return for their portfolio, and without a strong motivation behind their assumptions they will be subject to harder capital requirements [Svensk försäkring, 2011]. To know if an investment is worth its risk it is important to know the expected risk and return trade-off for each asset. This will assist in making better informed decisions, which hopefully in turn leads to higher pension benefits for the members.

1.3 Purpose and research questions

The purpose of this study is to investigate the effects of giving up liquidity in the portfolios of institutional investors. These effects primarily include risk measurements for liquidity and how liquidity risk can be quantified. The investigation of the effects is conducted in order to determine a level of required compensation, investors should demand to make an investment in an illiquid asset, in particularly real estate assets.

The purpose of the study will be met through answering the following research questions with the first two being more specific and the third research question more overarching of the field.

The questions that this study will answer are:

- What risk factors does real estate contribute to a portfolio?
- How much of the total real estate risk can be explained by illiquidity and how can illiquidity risk be calculated?
- What aspects in the overall portfolio affects institutional investors ability to invest in illiquid assets?

1.4 Limitations

We have selected to focus the work on the illiquid assets and in particularly real estate assets. This limitation is set in place as real estate is an asset class which has grown in
popularity amongst pension investors [Cameras, 2017]. This asset class has risks which are quite different from those risks associated with stocks and bonds [Brodin, 2017]. With this limitation, the focus of this study will be to investigate the effects of shifting from liquid assets to illiquid assets in the form of real estate.

When analyzing potential investments, which investment asset is most suitable will to a high extent be dependent on the individual investor and their investment strategy [Berk & DeMarzo, 2014]. All investors have different conditions with different investment horizons and varying portfolio sizes. This study will be limited to institutional investors, mainly pension funds. The main reason for this limitation is because of their sizes and amounts of capital which makes them able to make larger investments. Pension funds have a long time horizon, large amounts of assets under management and requirements to meet in terms of return and overall portfolio risk [Anveden, 2017]. These aspects make their investment strategies stand out from other investors; for example retail investors or short time horizon investors.

This study is conducted in Sweden and has also been limited to this geographical area, this limitation is used as there are differences between markets. General assumptions will be found globally but the research will be based on the transformation on the Swedish market and what implications it has on the Swedish market. Regulations and market conditions also differ between countries and are important factors for the investors. We are aware that the regulations and capital requirements which affect the target group for this study change frequently, and the relevance would be reduced if the regulations change, we have limited the study to current requirements but we have discussed the potential effect of regulatory changes that are currently being investigated.

1.5 The study’s contribution

One of the first influential studies on risk premiums was presented by Mehra and Prescott when they introduced the puzzle of risk premiums in 1985. Since Mehra and Prescott’s publication many studies have focused on estimating the risk premium for stocks [Pastor & Stambaugh, 2003], [Amihud & Mendelson, 1986]. However, the focus on risk premium for alternative investments has been limited in previously conducted studies. An alternative investment which has received some attention is real estate [Edelstein & Magin, 2012]. A few studies have been conducted on the risk premium in real estate, but to the best of our knowledge no previous studies have been conducted on the risk premium from real estate investments on the Swedish market and to what extent the liquidity influence the overall risk.

The area of liquidity premium in real estate and other alternative assets is fairly unexplored and the limited previous studies conducted have come to varying conclusions. This is partly because the definition of liquidity differ between researchers but also depending on methods and data used for the studies. Studies from the Netherlands and United Kingdom has discussed and developed the risk that arise from the unknown transaction period and asset liquidity [Bond & Huang, 2004], [Bond et al., 2007]. To the best of our knowledge, the area of liquidity risk and return from real estate on the Swedish market have not been researched prior to the start of this work. This study aims to build on the framework of Bond and Huang [2008] and apply their model to the Swedish market with
an addition of a qualitative analysis of concerns with investing in the asset class. This study can then contribute with a more complete overview of the risks associated with real estate.
2 Method

In this section of the report the methodology is described together with the research design. This describes the process of the study and also brings up considerations with for example research ethical guidelines and how these have been applied to the study together with reliability, validity and generalizability.

2.1 Research design

The method designed is to answer the research questions of including real estate in a portfolio and quantifying the risks this brings to an asset portfolio, including the liquidity risk factor. The initial step was to conduct a literature review which was designed to give an understanding of the potential risks that are present within real estate investments and how these are quantified. The method also included interviews with institutional investors, real estate companies, bank representatives and specialists to gain a better understanding on the investors opinions and their situations. In the next stage the liquidity risk was calculated using quantitative methods, this stage was conducted through an analysis of historical data. Historical data is used to evaluate the liquidity risk for alternative investments and comparing the risk with their return.

The work has been based on a deductive process and findings from the quantitative study are compared to findings in literature and interviews. Through the quantitative approach, general results can be found [Collis & Hussey, 2013] and this design serves the purpose of the study well. The qualitative part of the study is to answer the research question of the implications allied by alternative investments for institutional investors. However, using a deductive design, being critical becomes less natural [Collis & Hussey, 2013] and we have aimed to maintain critical throughout the research process as well as being open to reflections and opinions.

2.2 Research process

The work process of this study has been divided in to seven steps. The process is presented in chronological order, however, some of the steps were overlapping or conducted in parallel.

- **Pre-study** - In the pre-study the literature review was started. Two interviews were conducted to get a broader understanding of the subject and what the industry require more information about. From the pre-study the preliminary background, problematization and research questions was formulated.

- **Literature review** - Based on the research questions the literature review was continued and more focused. Concepts and theory was identified which could be further modeled and analyzed. The literature review was continued throughout the research process but with a majority conducted in the initial stages.

- **Interviews** - From the theory, questions were formulated which are of interest for the interview section of the study. Semi-structured interviews were then conducted with institutional investors, real estate companies, bank representatives and specialists.
• **Data collection** - Data was collected from the database Bloomberg, Nasdaq OMX Valueguard-KTH Housing Index (HOX) Sverige and MSCI:s IPD database. The data included historical stock, bond and real estate prices. All data used were collected in index form to give a generalized market view rather than object specific view.

• **Quantitative analysis** - With the collected data and based on the theory a quantitative analysis was conducted through using models to quantify the impact of risk factors.

• **Analysis** - The material collected from the empirical study together with the quantitative results were then compared and analyzed with theoretical findings.

• **Conclusions** - The results and analysis were then concluded to answer to the research questions.

2.3 Literature review

Literature on the subject was collected throughout the process but with a focus in the early stages of the research process. The literature review started of with a broad scope and was narrowed down as the research process evolved. The literature was collected through databases such as; KTH Primo, Google Scholar, Google Books and the Diva portal. The literature included information from journals, articles and books. All literature have been critically selected and when possible peer-reviewed processed papers have been used. As the topic is specific and the field of liquidity in real estate has not been broadly researched in Sweden, sources from other markets have been used. Most of the studies conducted within the relevant areas are based on data from the American market, but we have also used literature on studies conducted in the Netherlands and United Kingdom. There are some differences between the structures of the separate markets, including the size of the market and regulations impacting the market. We are aware of these differences and take this into consideration when using foreign studies, literature and findings. The following search words are words that have been included in the search process:

*Illiquidity, real estate, institutional investors, IPD-data, HOX-index, valuation, return, risk premium, illiquidity premium, risk appetite, risk management, asset management, asset liability management, asset pricing, performance, commission, transaction cost, transaction process, holding period, investment horizon, forced sales, investment structures, classification of real estate.*

2.4 Interviews

As part of the pre-study two interviews were conducted to gain a broader background knowledge. The first interview was an unstructured interview with the department of institutional advisory at SEB. The second interview was with a former PhD student in Real estate economics and now director and financial adviser in property investments, this interview was semi-structured in style. The interviews belonging to the pre-study were not recorded, however, notes were taken during both interviews.
To get a deeper understanding of the real estate market and the institutional investors’ views on real estate and their strategies when investing in the asset class, further interviews with real estate firms and institutional investors were performed. These interviews provided information with regards to the aim to increasing allocation to real estate and other illiquid asset classes. During these interviews information regarding expected holding period of their investments and the expected transaction times for the holdings in the illiquid asset classes, in particular real estate, were also collected. The expected holding and transaction period are required input data for modeling liquidity risk and information which is not available through data bases, this material was therefore collected through interviews.

2.4.1 Interview selection

The interview participants were selected to represent a diverse group with varying views, strategies and concerns regarding real estate investments. Through including real estate firms the process of direct investments could be understood and how a decision is taken and which factors are important when investigating in individual objects. From interviews with institutional investors and institutional sales the portfolio perspective of holding alternative investments could be understood. In the expert interviews other considerations and approaches were brought up.

The selection of some interviews was based on recommendations from our contact person at SEB. The selection also included AP funds as these have a large diversified portfolio and a long tradition of a fairly large allocation towards real estate, AP2 was excluded on account of their geographical location. The interviews have been limited to actors with their head office in Stockholm due to travel considerations. This may be a factor that impact our findings as the market which we have investigated are regional and may differ between areas in Sweden.

Real estate companies were also include in the interviews and the selection of real estate companies were based on company size. We also included geographical considerations when selecting real estate firms and also here limited the selection to Stockholm. Three real estate companies were finally selected to participate in the interview section. In addition to the previously mentioned interviews an interview was conducted with a smaller pension fund. This interview could contribute with the perspective of how the size impacts the view on real estate investment.

All conducted interviews are summarized in the following table:
The reliability of a study is increased with larger number of interviews, we did however reach an empirical saturation in our findings. As well as the empirical saturation we had to limit the total number of interviews held because of time considerations and having more interviews would have added diminishing marginal utility for each additional interview. We fulfilled the number of conducted interviews stipulated by Backer and Edwards [2012] which suggests between 12 and 60 interviews for a case study based graduate thesis. We have positioned the total number of interviews within this range, but are also aware that we are in the lower range of the spectrum. For this study interviews are however only one section of the study in combination with a quantitative approach.

2.4.2 Structure

All non pre-study interviews with the exception of three interviews were recorded, and notes were taken during all interviews. We did not, unless specific quotations were taken, transcribe the full length of the interview. After the interview the notes taken were, if needed, supplemented with transcriptions from the recordings. When asked for, the interview questions were sent in advanced to the interviewed persons, but for most interviews the questions were not requested. After the interviews the material was categorized and compiled, from the characterization conclusions and results could be found.

The semi-structured format, which was used for all except one interview, suited the study well as this format gave a basis of preparation of what the discussion was going to be about. With the possibility of asking additional questions clarifications could be made and the answers followed up to gain more information where the interviewee had more to add [Collis & Hussey, 2013]. One concern with this format is that the follow up questions posed during interviews differ between the participants and thereby reduce comparability between interviews. However the semi-structured format give the possibility to go into depth in the area of interest for the person and get additional insights.

<table>
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<td>Transaction &amp; Analysis</td>
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<td>Fabege</td>
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<td>Asset Manager; Real Estate</td>
<td>AP4</td>
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<td>FPK</td>
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<td>Executive Director</td>
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<td>G. Marcato</td>
<td>As. Pr. Real Estate Finance</td>
<td>HBS</td>
<td>Semi-structured</td>
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</table>

Table 1: Interview schedule
2.4.3 Ethical considerations

During the interviews the research ethics principles by Vetenskapsrådet [2002] has been applied and followed. The four main ethical considerations will be developed below.

- **Information** - All participants in the interview section were informed of the purpose of the study. When people were contacted and asked to participate in the interview section of the study the work was described, selection motivated and the type of questions going to be asked clarified.

- **Approval** - All interview participants approved to participation in written form through e-mails after the question of participation were sent with a brief description of the purpose of the study and the topic which was to be covered during the interview. Participants were also asked for their approval regarding the recording of the interview.

- **Confidentiality** - All participants were given the option to participate anonymously. In the study none of the participants requested to participate anonymously.

- **Use of findings** - All information collected for the study will only be used for the purpose of this study. All participants were made aware that this study will be public once finished. All recordings will be deleted after the completion of the study.

2.4.4 Classification of empirical material

After the interviews the gathered material was collected and classified according to category. Some questions asked during the interviews were used for the quantitative modeling. The remaining information was used to understand the investors behaviors and other aspects of real estate investments. The material was classified into the categories: the balance between risk and return in investments, illiquidity, transactions and the asset from a portfolio perspective. The findings can be found in section 4.

2.5 Data collection

The qualitative section of the study is based on historical data. The data included in this study are: historical stock, bond and real estate prices. Historical stock and bond prices was obtained from the database Bloomberg. Finding historical data on physical real estate is more challenging as there are only price information available when a transaction has been conducted. Another problem with real estate data is that objects included in for example indexes are not identical, unlike for example stocks. To combat this issue, data on real estate indexes as MSCI’s IPD-index and Nasdaq OMX Valueguard-KTH Housing Index (HOX) Sverige has been used. In addition, data on expected transaction period and expected holding period was used, this data could be obtained through interviews and deducted from data.

2.5.1 Housing index - HOX

The Swedish Nasdaq OMX Valueguard-KTH Housing Index (HOX Index) is based on a hedonistic price model with monthly price updates. Data in the HOX indexes includes privately owned flats. The data for the index is collected through Mäklarstatistik AB, and
multiple regression is then used to adjust the transaction price for the descriptive factors of the particular object sold. These factors includes indicators such as; size, number of rooms and location and is used to calculate the price development for what is defined as a 'normal property'. This method require less data then comparing transactions of the same object, in which repeated transactions of the same object is used. An issue with a hedonistic index is that it is subject to the appropriate definition of the model. The weighing of the HOX index is adjusted every six month to appropriately reflect the distribution of completed transactions. [Valueguard, 2011]

2.5.2 Property index - IPD

For data of different segments within real estate investments the MSCI Swedish annual property digest was used. These data include historical index changes between the years 1983 and 2016. In this data real estate is categorized as retail, offices, industrial and residential properties. The data is based on valuations and not transactions as other indexes. It included in total 3937 properties in year 2016 [MSCI, 2016]. From the IPD data bank only data on the Swedish market have been used, IPD data is updated annually.

2.5.3 Considerations with data

The transaction based HOX index gives an indication of price changes and the IPD index on how the valuations are changing for the whole market and segments but not for particular objects, and these indexes are not pure transaction data from re-sold properties. The quantitative findings would have had a higher reliability for single objects if the data used was only from that object. However, the general market trend is more interesting for the study then specific cases and therefore the data used is representative and serves the purpose of the study well.

Through collecting data from databases the study will be based on secondary data [Collis & Hussey, 2013]. Part of the data is historical stock and bond prices. This is public data which can be assumed to be accurate. Through using IPD index and HOX index data their way of collecting data will have to be trusted and it is important to understand what type of real estate that is included in the indexes and from what market data is taken to make a comparable study.

A limitation in the real estate data used for the study is the infrequent reporting of data. IPD data is only available on an annual basis and HOX on a monthly basis. This limitation is however compensated for by the long time series available, giving enough data to do reliable statistical investigations. The long time series also includes data from several market cycles. Using historical data to predict future outcomes is another limiting factor in all forward looking studies. We will use historical data as a proxy for future outcomes and the applicability of this will be limited to the assumption that historical information is a good proxy for future events.

2.5.4 Smoothed data

Real estate data have the bias of insufficient transaction data during recessions. Data on prices in real estate only become public when a transaction is successful. This makes data biased as failed trades and desolated properties are not included in the
index [Edelstein & Quan, 2006]. In addition valuation based indexes, as the IPD-index, have the problem that the fluctuations in price can not always be visible in the data. This can be caused by the fact that valuations differ from actual market prices and have a time lag. The time lag arise as valuations are based on previous valuations and not carried out so frequently. These factors make real estate valuations smoothed. To be get comparable real estate investments the de-smoothing was conducted to compensate for the issues arising from real estate valuations [Geltner, 1992].

In order to adjust for indexes being based on valuations rather than transactions, the approach of de-smoothing of real estate indexes is used. The theory behind this approach is described in section 3.6.5. The other data set used, Nasdaq OMX Valueguard-KTH Housing Index (HOX) Sverige is transaction based residential real estate data, as the HOX-index is transaction based, no de-smoothing is used on this data.

2.6 Quantitative analysis

The data collected was then used for calculations in accordance with a model developed by Bond and Hwang [2004]. Their model is designed to generate the ex-ante variance. The ex-ante variance is the variance of both the holding- and the transaction period. Based on the ex-ante variance model, a scaling factor for the variance can be calculated from the index-data.

The adjusted variance can then be used for calculating an adjusted Sharpe ratio for real estate, which then in turn can be compared to the Sharpe ratio for equities. Under the assumption that all risks are rewarded, this is used to calculate how much of the real estate return that should be allocated to the transaction period risk. This will however, be an approximation as there are other risk factors that needs to be accounted for other than liquidity risk and market risk.

In addition to these steps an investigation of the effect of a potential forced sale on the expected return for the asset as to investigate the risks associated with having less liquidity and thereby having longer transaction periods. These calculations were carried out on hypothetical cases formed by findings from the literature review and interviews. A situation of forced sales can also be used to show up some of the implications for illiquidity from which a liquidation bias premium can be calculated.

2.7 Source criticism

Throughout the work stringent source criticism have been applied. The literature used has either been published in a journal or as a independent book by a known publisher. To the highest degree possible more than one source have been used in order to confirm the findings. Interviews or findings from this study have, in the cases where possible been allowed as source confirmation. We have throughout the work aimed for triangulation of all findings. Triangulation entail finding at least three independent sources of information leading to the same conclusion [Collis & Hussey, 2013]. For most sections of this report triangulation has not been possible as we only have literature and interviews supporting our findings.
2.8 Validity and reliability

Validity is that the right thing is studied and part of this is that a suitable method is chosen for the purpose of the study. Reliability is that the thing is studied the right way, this can be how results are measured or interpreted [Blomkvist & Hallin, 2015]. Reliability is connected to the objectiveness of the researcher and to the extent another researcher would come to the same conclusions [Collis & Hussey, 2013].

In the quantitative part of the study the reliability is high since both the method and data used are presented and the study could therefore be replicated with the help of publicly available data. Illiquidity is a term that can be interpreted in different ways and researches do not have one definitive definition of what the term actually entail or how it should be used. The different definitions of liquidity and what it actually is could decrease the validity since going by Blomkvist and Hallins [2015] definition of studying the right thing depends on the individual definition. To work with this it is important to be clear when defining what definition we work with.

In the quantitative part of the study validity was created through having several, carefully formulated questions. The reliability was enhanced as during most interviews there were two persons interpreting the answers from the interview and also having several interviews. However, reliability decreases as a result of the semi-structured format of the interviews and that different follow up questions were asked in different interviews. This is not unexpected since results from research in social science rarely can be replicated [Blomkvist & Hallin, 2015].

2.9 Generalization

The ability to generalize the findings from this study will be limited due to the limitations described in section 1.4. The models used is however generalizable and the method used are suitable for use in wider markets. As the interview section is designed to account for the specific market conditions in the Swedish market and the regulatory conditions of this market, the interview findings should not be considered generalizable to a wider market, but can be used for comparable purposes between markets. With regards to other investor types the findings are limited to investors with a long time horizon and large amounts of capital under management, a generalization past this group would not be possible due to the inherent aspects of real estate investments.
3 Theoretical background

In this section of the report previous literature and studies conducted within the field are presented. This includes mathematical and theoretical frameworks which are to support the research questions. The frameworks include Sharpe ratio, characteristics, categorization and factors of liquidity, ex-ante variance, liquidation bias and risk frameworks.

3.1 Traditional asset pricing

Investments in different assets face different risk factors. The return from an investment is expected to increase as the risk associated with the asset increase and the more risk an investor is willing to accept the larger is the potential portfolio return [Berk & DeMarzo, 2014]. Several models have been developed to calculate the expected return on traded investments and the models usually refers to traded stocks as the risky investment [Cornelius et al., 2013]. To compare the risk with the return from a particular asset the Sharpe ratio is a measure commonly used. The Sharpe ratio is calculated as follows [Sharpe, 1964]:

\[
\text{Sharpe ratio} = \frac{\text{Expected return} - \text{Riskfree rate}}{\text{Standard deviation}}
\]

When assets are priced the pricing is usually based on the expected return of the asset based on its expected future cash flow. For pricing the Capital Asset Pricing Model (CAPM) is a model frequently used. From this model an assets price can be calculated form the underlying parameters of; risk-free rate, the expected market return and how the asset is moving in comparison to the market (\( \beta \)) [Brennan, 1998]. Fama and French [2015] extended CAPM and originally developed the three factor model from which stock returns could be explained by company size, price to book value and market risk. The model has continuously been developed, the model currently include up to five factors [Fama & French, 2015].

One extension which has been added to the three factor model developed by Fama and French has been to include liquidity. This extension is to account for the liquidity premium in stocks. The descriptive factors which is used to account for liquidity include for example trading volume and bid-ask spread amongst a multitude of factors. Bid-ask spread and trading volume are parameters that are measurable on the stock trading markets but these parameters on alternative investments are not readily available or measurable from available data [Pastor & Stambaugh, 2003].

Considering the underlying performance and expected return from stocks the general ideas are the same also for alternative investments with a lower level of liquidity. The price is set from future payouts, how the asset class is performing in comparison to the market and what risk the investment imply [Brennan, 1998]. Just like with stocks leverage can be used to increase the expected return through increasing the exposure towards the underlying risky asset [Lang et. al., 1996].

3.2 Allocation decision

Assets perform differently depending on which risk factors it is exposed to and through a combination with assets exposed to other risk factors the overall portfolio risk can be
reduced for a expected return than individual assets give at the same risk and an optimal portfolio is then created, this is known as differentiation. For effective differentiation the correlation between assets is of importance. The overall portfolio risk reduction increase as correlation between assets in the portfolio decrease, optimally a correlation of minus one would remove the total risk.

Traditional portfolio optimization is carried out through the mean-variance optimization framework where an efficient frontier is found based on the correlation between assets and each assets individual risk and return profile. The investor can then from the efficient frontier select the portfolio which best fit their portfolio requirements [Berk & DeMarzo, 2014].

### 3.2.1 Institutional investors portfolio management

Portfolio management differ between individual investors and institutional investors also in that institutional investors usually have a liability side in their portfolio. For pension funds with future payments other approaches of assessing what the optimal portfolio would be is through the Asset Liability Model (ALM) or Asset Only Model (AOM). In the ALM framework the aim is to match the assets with the liabilities, both in terms of size and duration. In the AOM framework only the assets are considered [Hoesli et al., 2003]. Hoseli et al. [2003] finds the optimal allocation to real estate ranges between 15-20% in a AOM framework and the optimal allocation in an ALM framework is around 10%. The range is depending on the investors ability to accept different risk levels in the portfolio. The same study also found that the actual allocation to real estate among pension funds in Sweden is about 8% which is lower than the range suggested by either optimization framework [Hoesli et al., 2003].

A presumption for effective portfolio management is that the portfolio can constantly be re-balanced and that way always strive towards an optimal allocation. Investing in less liquid assets implies a risk for the investor as the portfolio will lose some of its ability for continuous re-balancing. To compensate for this the investors demands a premium to take on the re-balancing risk. [Cornelius et al., 2013]

### 3.3 Illiquidity

The definition of the term *liquidity* vary between studies. An illiquid asset is in simple terms an asset which is harder to sell than a liquid asset. The harder it is to sell an asset at market price the more illiquid the asset [Amihud & Mendelson, 1986]. Anson et al. [2011] define an illiquid asset as an asset which takes time to convert into cash. Liquidity can also be described in terms of the ability to trade large volumes of the asset without impacting the price and to being able to trade at a low cost [Pastor & Stambaugh, 2003].

Damodaran [2005] on the other hand claim that the term illiquidity is occasionally misleading since all assets can be traded at all times; it is just a question of what price the seller is willing to accept. Meaning that there are no truly illiquid assets, it is just a scale depending on how much reduction in price the seller would have to accept to trade at a give time. The issue with falling prices at the time of transaction is often referred to as price impact. Damodaran defines illiquidity through the cost that would appear if a reversion of a decision occurs and a trader who bought an asset would immediately sell
the asset. Damodaran [2005] claim that the price impact can be used to measure liquidity of a particular asset. A frequently traded, publicly owned asset has a low risk of implying high transaction costs, and thereby have low price impact. What cost there will be for completing an transaction is dependent on the number of potential buyers but can also differ between financial securities and real assets [Damodaran, 2005].

3.4 REAL ESTATE AS ILLIQUID INVESTMENT

Investing in real estate can have characteristics and bring risks other than those from traditional assets such as stocks or bonds. Real estate is considered an illiquid investment according to some of the definitions above [Girling, 2013] [Ang, 2014]. The part of the risk that can be measured in assets is related to the volatility, but for some investments there is also a part that is related to uncertainty. It is the uncertainty or immeasurable risk that generate liquidity risk [Cornelius et al., 2013]. When it comes to stocks, liquidity is affected by three factors. These factors are; the price impact, that is the transaction cost the investor will have buying or selling and asset, the bid-ask spread and the opportunity cost for waiting of completing the transaction [Damodaran, 2005].

Ametefe et al. [2015] identify five characteristics that can be used to describe liquidity and which could also be used for alternative investments, including real estate:

- **Tightness** - The cost of trading
- **Depth** - The ability to trade without impacting the price
- **Resilience** - How increased trading quantities is affecting the speed at which the marginal price changes
- **Breadth** - The total volume traded
- **Immediacy** - The cost arising when having to sell an asset quickly.

![Figure 2: Graphical representation of liquidity characteristics](Source: Ametefe et al. [2015])
3.4.1 Methods of investing in real estate

Investing in real estate can be done in four main ways, each with different levels of liquidity, these are; direct through private equity, public equity through for example Real Estate Investment Trusts (REITs), public dept as Mortgage Backed Securities or private debt as direct lending [Lekander, 2016].

In addition fund structures can be used to gain exposure to real estate or for investing in the asset class. These fund structures can either be structured as open or close ended funds. A close ended fund has a date of maturity and money can not be withdrawn until this date [Russell, 2007]. An open ended fund has got the option to issue or redeem shares at any time. This means that investors buy into the fund from the issuer rather then in a market place with the price of each share issued directly represent the market capitalization of the fund [Edelen, 1999].

3.4.2 Reasons to invest in real estate

The decision to invest in real estate can come from different portfolio requirements for different investors and these investors therefore select different ways of investing in the asset class. Investments in real estate can for example be included in a portfolio to give returns higher than interest rates, global investment opportunities or as a way of receiving stable cash flows [Anson et al., 2011]. The value created in the real estate industry comes from the demand for a place to live or operate and the asset holders get a yield from rents paid and maybe also return from increased asset value [Baker & Chinloy, 2014]. Investing in real estate can also provide good portfolio differentiation as it is connected to other kinds of the systematic risk factors than stocks and bonds, for example liquidity related risk factors [Anson et al., 2011].

Another reason to invest in real estate is according to Anson et al. [2011] the inflation hedge real estate assets can provide as rent levels are often adjusted for inflation, i.e. the rent increase with inflation during the duration of the contract. The inflation hedge that real estate offer is a debated subject and Ang [2014] concludes that real estate a poor hedge against inflation. During bad times in the market the liquidity in real estate objects will go down, which will have a negative impact on the portfolio flexibility. Liquidity levels for real estate assets are hard to draw general conclusions about since the liquidity depends on location and characteristics related to individual objects.

3.4.3 Categorization of real estate

Direct real estate investments can be described in several ways. Objects differ, which makes them hard to compare and affects the level of risk in each object [Lekander, 2016]. The CAIA Association [2016] has created a classification of real estate objects by eight characteristics, these are;

1. Property type - what the building is used for
2. Life-cycle phase - if the object is newly built or an existing building
3. Occupancy - if there are tenants or if the building is vacant
4. Roll over concentration - frequency of trades in the asset
5. **Near term rollover** - probability for trade in near future
6. **Leverage** - if loans are taken to finance the investment
7. **Market recognition** - the extent to which the asset is known to institutions
8. **Investment structure** - the extent of control and governance

Based on these eight real estate characteristics objects can be divided into three sub groups; Core-, Value-added- and Opportunistic real estate. A real estate portfolio with objects from the Core sub group will have low leverage and an open-ended structure. This type of portfolio has stable returns and comparatively low risk. A Value-added portfolio can consist of a mix of value-added and other investments and more leverage, up to about fifty percent. In a Value-added portfolio incomes are less stable and the risk level higher than in a Core portfolio, because of the higher risk the expected return is also higher. The third type of portfolio is the Opportunistic, which has higher risk and where a higher return is demanded. The risk can come from several sources, some are; high leverage, leasing risk and development risk [CAIA Association, 2016].

### 3.5 Risk compensation for liquidity

When trading in illiquid assets the investors face risks which need to be compensated for. Most illiquid assets are affected by a illiquidity discount. The size of the illiquidity discount is effected by both the transaction cost and the expected holding period for the asset. The longer an investment is expected to be held, the lower the illiquidity discount and the higher the transaction cost, the larger the illiquidity discount. This effect is quite self-explanatory as if an asset is traded with a 5% transaction cost and expect to be held for one year, the asset would have to at least increase 5% in value for the investment to break-even [Damodaran, 2005].

The exogenous transaction costs i.e. the direct transaction costs such as brokerage fees and transaction taxes affect the liquidity of the asset. The direct costs are however not the only costs that arise when trading in illiquid assets, there are also costs that arise from the risk that illiquidity brings [Easley et al., 2000]. These liquidity risks include demand pressure and inventory risk. Inventory risk arises from the risk of not getting the asset sold when wanted. Demand pressure is the risk for the investor of not finding the right buyer at the time when the investor wishes to sell [Easley et al., 2000]. Liquidity problems usually arise in periods of market turmoil, for example that could be when bubbles burst or changes in the risk concentrations [Carrel, 2010].

#### 3.5.1 Liquidity premium

Previous studies on the area of liquidity premium in alternative investments or real estate are limited as discussed in the introduction and no studies have been found on the Swedish market. The few studies that have been carried out comes to different conclusions depending on how liquidity is defined and how this is calculated. Ang [2014] finds the yearly liquidity premium for inflation protected securities to be around 0.5% with a peak of 2.5% during the 2008 financial crisis. Hordijk and Teuben [2008] on the other hand finds the annual liquidity premium in the Netherlands to range between 0.09% - 0.31%. Marcato [2015] concludes that the premium is around 3% in the United Kingdom, but varying between 1.5% up to 10% depending on market conditions.
3.6 The illiquidity risk in real estate

The liquidity risk in real estate can arise from different liquidity factors. Hordijk and Teuben [2008] have divided the liquidity risk associated with real estate investment into five risk liquidity risk factors, these are:

- Opportunity risk
- Liquidity risk for incomes
- Accurate valuation risk
- Heterogeneity risk
- Transaction process risk

These factors will furthered be explained in the now following sections.

3.6.1 Opportunity risk

The opportunity risk is the risk of missing other investment opportunities because of the decision to allocate money to a particular asset. With variables for the return from an alternative investment during the holding period and the transaction period ($E_{h+t}$), the return of real estate during the holding period ($R_h$) and the incomes during the transaction period ($R_t$). [Hordijk & Teuben, 2008]

$$\text{Opportunity cost} = E_{h+t} - (R_h + R_t)$$

3.6.2 Liquidity risk of incomes

The liquidity risk of incomes is the risk that properties become vacant and therefore not generating the expected cash flows. This could for example happen if tenants defaults or in some other way not are able to pay their rents [Hordijk & Teuben, 2008]. This can be considered as a counter party risk factor [Girling, 2013]. The liquidity risk of income is affected by the number of possible tenants and the attributes of the object. According to the CAIA Association [2016] and their classification of attributes this risk is largest for Opportunistic objects in comparison to Core investments which have a lower degree of liquidity risk of incomes.

3.6.3 Heterogeneity risk

Another component in liquidity risk is the heterogeneity risk. That is the difficulty in comparing objects, as each property is unique. Units of real estate differ and there are more differences compared to trading one stock which is always the same, given the same class and company. Within the real estate investment spectrum it is not only the object that differs, there are different ways to invest in real estate as for example office buildings or residential buildings and to direct or indirectly in the asset. Hordijk and Teuben [2008] argue that heterogeneity risk is not of big importance to the overall risk. Heterogeneity risk can in some cases also be connected to the concept of information imbalance as you do not know what you get when you but a property.
Information Imbalance - A problem which is present in illiquid transactions is the information imbalance between the buyer and the seller which is causing an information gap. In the real estate case it is common that the seller knows more about the asset than the buyer. This leads to a risk for the buyer, that the seller is selling based on some private information [Easley et al., 2000]. In order to combat this issue, there is commonly a due diligence period when doing large transactions. The due diligence process aim to give the buyer increased knowledge of the property and reduce the risk that the seller had private information which would drastically reduce the property’s value. The due diligence period is costly and contributes to the high transaction cost as well as it increase the transaction period [Roulac, 2000].

3.6.4 Accurate valuation risk

Studies have shown that there is often a discrepancy between the latest valuation and the sales price [Geltner, 1992], [Englund et al., 1999], [Kaplan, 2012]. The pattern that has been seen is that the last valued price usually is lower then the sales price, it should be added that this pattern have been obtained in a period of a positive market trend and it might be different to results in falling markets. The difference between sales price and appraisal can be divided into two factors; a lagging error and a random error. The lagging error is dependent on the market development since the appraisal date. The random error consist of the time lag, information lag and a random error term [Hordijk & Teuben, 2008].

The valuation risk i.e. the risk that assets can not be sold at the appraised value can be explained by two factors: market debt and nonlinearity of market functions [Carrel, 2010]. Market depth is the volume that can be traded without affecting the market prices or spreads. Nonlinearity of the market function is the lack of information during the transaction period. The lack of transparency in the real estate market makes it hard to estimate prices in the market and is dependent on the time horizon and purpose for the trade and therefore affect the valuation of assets and the value of the portfolio.

3.6.5 De-smoothing real estate returns

To compensate for the difference between the appraised value and the price obtained at transaction a method referred to as de-smoothing is commonly used. Smoothing is the process when peaks and lows of values are not as high or low as they would have been if transactions were used. One reason for the smoothing is that the valuations are slow in responding to changes in the market and valuators are cautious when valuating a property. The de-smoothing process can also be used to compare value based real estate indexes and transfer these to comparable transaction prices [Geltner, 1992].

Kaplan [2012] finds evidence for the smoothing caused by appraisal and motivates this by the historical performance of stocks, bonds and real estate between the years 1926 until 1992 on the American market. During this period stocks gave a return of on average 10.5% and real estate 8.5% per year. At the same time real estate produced a risk lower than that from bonds and without correlation to either stocks and bonds. This would imply that real estate is a superior investment and the efficient portfolio should only consist of real estate. This have not been the case and Kaplan [2012] motivates this by the smoothing taking place caused by the appraisal process. Evidence
of auto-correlation between data points of returns has also been found on the Swedish market [Englund et al., 1999].

In order to combat issues with data auto-correlation the process of de-smoothing can be applied to the data. The de-smoothing process aims to return the variance which is at the risk of being eliminated through the valuation process. The formula for de-smoothing can be written as [Geltner, 1992]:

\[ V_t = \alpha P_t + (1 - \alpha)V_{t-1}. \]  

(1)

In the de-smoothing process the value at time \( t \) is \( V_t \), and can be calculated as a function of the valuation one time unit before and a factor for comparable sales taking place at the same time. To balance these two factors a de-smoothing factor \( (\alpha) \) is introduced [Netzell, 2010]. The de-smoothing factor \( (\alpha) \) is time and situation dependent. Geltner [1992] finds that \( \alpha \) usually range between 1/2 to 2/3. From equation (1) the de-smoothed value \( P_t \) can be found:

\[ P_t = \frac{V_t}{\alpha} - \frac{(1 - \alpha)V_{t-1}}{\alpha}. \]  

(2)

The main concern with using the de-smoothing process described above is that it is dependent on the choice of \( (\alpha) \), which can not be determined from factors measurable in the market. The larger the value of alpha the larger the variance in the de-smoothed time series [Netzell, 2010].

3.6.6 Transaction period risk

Transaction period risk is the uncertainty of how long the marketing period will be from the time of the decision to sell an asset. This uncertainty gives rise to other risk factors than those that can be measured using for example standard deviation. Bond and Huang [2004] formulated a method for calculating the volatility during the transaction period. They claim that real estate indexes tend to overlook the excess risk that arise from an unknown transaction period. The uncertainty leads to real estate as an asset class having higher risk than that which can be seen through measuring the index volatility. The transaction process risk measure, ex-ante variance, aim to give a measure by which the volatility can be scaled to appropriately represent the risk during both the holding period and the transaction period. This measure does not account for the other risk factors that may a\( \frac{1}{\alpha} \)fect the total risk for illiquid assets.

The transaction period risk is dependent on two main factors; the expected holding period and transaction period [Bond & Huang, 2004]. The average holding period for offices and retail real estate is around 13 years and approximately 25 years for residential real estate on European markets [Collett et al., 2003], [Hordijk & Teuben, 2008]. In stock markets the implied holding period is usually calculated as the outstanding volume of shares divided by the traded volume [Atkins & Dyl, 1997]. Collett et al. [2003] have correspondingly formulated a formula to calculate the implied holding periods from IPD data of real estate. This approach is limited as different assets have different holding periods as some are traded frequently and other less frequently. This approach is also limited as the institutions reporting to IPD can change during years. However, Collett et al. [2003] come to the conclusion that this measurement can be used as a proxy for
implied holding period as only studying individual transactions would miss out on objects not getting sold.

\[ Holding\ Period_t = \frac{(Nr.\ of\ Properties_t + Nr.\ of\ Properties_{t-1})}{Sales_t} / 2 \]  

Based on IPD-data Hordijk and Teuben [2008] come to the conclusion that the transaction period in the Netherlands is usually between two and six months. They compare these results to other European markets and find that they are similar in other countries in Europe.

![Figure 3: Transaction period](image)

Source: Hordijk & Teuben, 2008

The decision to sell a real estate asset goes through the following steps in the transaction process [Hordijk & Teuben, 2008]:

![Figure 4: Transaction stages](image)

Source: Hordijk & Teuben, 2008

3.6.7 Framework for calculating transaction risk

A framework for accessing the transaction period risk in illiquid investments has been developed by Bond and Huang [2004]. Their framework is based on an assumption that returns are normally distributed and that the transaction time follow a exponential distribution. From the distribution assumptions mean and variance for the return can be calculated from available data. The transaction time can be estimated through information from interviews. The following variables will then be introduced for calculation of transaction risk:
<table>
<thead>
<tr>
<th>Notation</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>( h )</td>
<td>Holding period</td>
</tr>
<tr>
<td>( t )</td>
<td>Transaction period</td>
</tr>
<tr>
<td>( r )</td>
<td>Return</td>
</tr>
<tr>
<td>( \mu )</td>
<td>Average return</td>
</tr>
<tr>
<td>( \sigma^2 )</td>
<td>Variance of return</td>
</tr>
<tr>
<td>( \lambda )</td>
<td>Parameter for sales distribution</td>
</tr>
</tbody>
</table>

Table 2: Introduced variables

Ex-post risk and return is defined as the time the investment will be held before it is sold, including the time for the transaction. The expected return and variance ex-post is \( \mathbb{E}^P(r_{h+t}) \) and \( \text{Var}^P(r_{h+t}) \). Ex-ante the risk of doing the transaction is not known and this have to be compensated for in the terms \( \mathbb{E}^A(r_{h+t}) \) and \( \text{Var}^A(r_{h+t}) \).

\[
\mathbb{E}^P(r_{h+t}) = \mathbb{E}(r_{h+t}|h + t) = \mu(h + t) \tag{4}
\]
\[
\text{Var}^P(r_{h+t}) = \text{Var}(r_{h+t}|h + t) = (h + t)\sigma^2 \tag{5}
\]

In the ex-post formula the transaction period is known. This is not often the case in real estate investments and this implies a transaction risk which is to be considered a liquidity risk.

\[
\mathbb{E}^A(r_{h+t}) = \mathbb{E} \left( \text{Var}(r_{h+t}|h + t) \right) + \text{Var} \left( \mathbb{E}(r_{h+t}) \right) = \mathbb{E} \left( \text{Var}(r_{h+t}) \right) + \text{Var} \left( \mathbb{E}(r_{h+t}) \right) \tag{6}
\]

Using the expressions from (4) and (5) the equation can be rewritten as follows, where \( \mu_e \) is the expected sales period and \( \sigma_e \) the expected standard deviation for the sales period:

\[
\text{Var}^A(r_{h+t}) = (t + \mu_e)\sigma^2 + \mu_e^2\sigma_e^2 = \frac{1}{(t + h)} \left( (t + \mu_e) + \frac{\mu_e^2}{\sigma^2\lambda} \right) \text{Var}^P(r_{h+t}) \tag{7}
\]

Under the assumption that the transaction time is exponentially distributed with parameter \( \lambda \). The expected time for transaction will be Poisson distributed with parameter \( \lambda \) both the expected value and the standard deviation of the distribution is \( \lambda \).

\[
f_\lambda(t) = \frac{e^{-t/\lambda}}{\lambda} \tag{8}
\]

Insertion of this in the ex-ante formula gives;

\[
\mathbb{E}^A(r_{h+t}) = \mu(h + \lambda) \tag{9}
\]
\[
\text{Var}^A(r_{h+t}) = \left( \frac{\mu^2}{\sigma^2(t + \lambda)} \right) \text{Var}^P(r_{h+t}) \tag{10}
\]

The term which scales \( \text{Var}^P(r_{h+t}) \) to \( \text{Var}^A(r_{h+t}) \) is then the factor with which the variance has to be multiplied with to include the transaction risk, i.e. the factor representing the transaction process risk. This term will be refereed to as the ex-ante variance scaling factor or the ex-ante scaling factor. The ex-post variance is the risk measurable in the index over the holding period and transaction time.
3.7 Forced sales

Another component of liquidity presented in the model of Ametefe et al. [2015] is immediacy. For an illiquid assets the risk of forced sale, or in some cases known as fire sale, can result in considerable consequences. A forced sale is characterized by a shorter transaction period than that required to obtain market price. The reasons for forced sale vary, but it may be associated with an immediate demand for liquidity or changing market conditions [Donner et al., 2016], [Campbell et al., 2011]. The cost of liquidation in real estate is different to the financial market in which market prices can be obtained instantly. This is a risk that is not reflected in the prices as most sellers have been prepared for the transaction for a time and the price is then reflecting recent prices [Lin & Vandell, 2007].

The cost of forced sale, or the reduction in price is highly dependent on market conditions and the size of the reduction in transaction period. In a study on Swedish residential real estate sold by the Swedish enforcement officer the reduction in transaction price is estimated to range between 22% and 29% depending of the reason for the forced sale, which also impact the average transaction time for the forced sale [Donner et al., 2016]. These sales are mainly single family homes and not the larger lot sizes commonly associated with institutional investors. This risk should however not be ignored for institutional investors either even though few earlier studies have been conducted on the consequences for institutions. Overall the liquidation risk premium for properties can be computed through the model developed by Lin and Vandell [2007].

3.7.1 Liquidation bias premium

To compute the impact of liquidation Lin and Vandells [2007] measure, liquidation premium can be used. If transaction prices and market valuations are assumed to be uniformly distributed the liquidation bias premium can be calculated as the difference between the transaction value and market value \( \mu_T - \mu_M \) with volatility bias as the difference between the market variance and the transaction variance \( \sigma_M - \sigma_T \).

\[
i = \{T = \text{Transaction, } M = \text{Market valuation}\}
\]

The variables used can be seen in the following table:

<table>
<thead>
<tr>
<th>Notation</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>( h )</td>
<td>Holding period</td>
</tr>
<tr>
<td>( R )</td>
<td>Average return</td>
</tr>
<tr>
<td>( P_t )</td>
<td>Price at time ( t )</td>
</tr>
<tr>
<td>( p^* )</td>
<td>The sellers reservation price</td>
</tr>
<tr>
<td>( \mu_i )</td>
<td>Average return</td>
</tr>
<tr>
<td>( \sigma_i )</td>
<td>Standard deviation</td>
</tr>
<tr>
<td>( \lambda )</td>
<td>Transaction time, (( \lambda = 0, 1, 2.. ))</td>
</tr>
</tbody>
</table>

Table 3: Introduced variables for liquidation bias premium

Under these conditions and with the transaction period \( \lambda = 0, 1, 2.. \) and the prices at every period represented by \( P \), the average return for the holding period is calculated as:
\[ R_{h+\lambda} = \frac{P_{h+\lambda} - P_0}{P_0} \]  

(11)

Where the observed data of transaction prices are only presented in cases when the bid price exceeds the asked price. In the equation \( p^* \) represent the sellers reservation price.

\[ P_{h+\lambda} = \begin{cases} \frac{P_{\text{bid}}}{P_0}, & \text{if } \frac{P_{\text{bid}}}{P_0} \geq p^*(h + \lambda) + P_0 \\ \text{unobserved}, & \text{if } \frac{P_{\text{bid}}}{P_0} < p^*(h + \lambda) + P_0 \end{cases} \]

From the uniform distribution assumption this makes the average return from the transaction and the market valuations as follows

\[ \mu_{h+\lambda}^T = \frac{P^T}{P_0} \]  

(12)

\[ \mu_{h+\lambda}^M = \frac{P^M}{P_0} \]  

(13)

These can be used to calculate the liquidation bias premium and corresponding volatility. \( E[T] \) is the estimated marketing time. For the full proof of the formula see Appendix 1.

\[ \mu_T - \mu_M = \sqrt{3} \cdot E[T] \cdot \sigma_T \]  

(14)

\[ \sigma_M - \sigma_T = E[T] \cdot \sigma_M. \]  

(15)

3.8 **LIQUIDITY RISK APPETITE**

The investors risk level will determine the potential return for the portfolio [Berk & DeMarzo, 2014]. Moorad [2011] divide the liquidity risk appetite into four factors; regulatory requirements, internal constraints, stake holders objectives and external factors. An investors risk aversion can also depend on the portfolio structure and the liabilities which the investor face. The liquidity risk appetite depend on factors such as; maturity mismatch, maturity transformation, funding structure, exposure to other currencies and the amount of liquid buffer capital [Moorad, 2011].

3.8.1 **RISK APPETITE FRAMEWORK**

The Risk Appetite Framework (RAF) has been developed to, within a company, better monitor and communicate the risk they are willing to accept. In the RAF framework the risk appetite is defined as; "The aggregate level and types of risk a financial institution is willing to assume within its risk capacity to achieve its strategic objectives and business plan" [Financial Stability Board, 2013]. Within a company the risk appetite is affected by a multitude of factors, the relationship between the factors can be seen in the figure.

![Figure 5: Relationship risk management](Source: Girling, 2013)
The risk capacity is a portfolio’s or company’s ability to absorb risk and depends on; the capital the fund holds, need for liquidity and its operational structure. The risk tolerance is risk that can be taken without risk mitigation. The risk limits are the risk levels at which risks are considered and started to be monitored. Amongst these levels there is an escalation upwards and governance is acting to control and limit risk [Girling, 2013].

3.8.2 Managing liquidity risk

Liquidity risk arise from factors which cause imbalance between assets and liabilities. The changes can take place externally and then affect the funding sources or internally, changing the value of collateral or assets. Carrel [2010] state that the best way to hedge the liquidity risk is to actively work with liquidity management. This includes a continuous adjustment of balance sheet liabilities and structures. From an internal perspective this means managing assets, funding and collateral. The adjustments are to account for the external risk factors, in order to mitigate the risk of changes and shocks in the market.

Managing asset liability risk is usually a process of matching the duration and sensibility of assets with the duration and sensibility of the liabilities. A liquidity risk arise when the duration and sensitivity of the assets and liabilities are mismatched. To match liabilities with assets is a complicated process because of volatility, liquidity and the difficulties in monitoring all risk factors in the market. During the financial crisis in 2008 liquidity risk rose from external factors either as counter-party risk or regulatory driven risk [Carrel, 2010].

Carrel [2010] created a framework to monitor and manage liquidity risks through three factors; asset liability management (ALM), valuations and sensitivity in valuations and tracking risk concentrations and the factors causing this. A risk strategy should be developed that is supported by regulatory requirements, corporate responsibilities and which monitor the market and liquidity risk. The basis for the framework should be the company’s risk appetite and strategy. In the risk management strategy also the time horizon of the fund and its liabilities needs be taken into consideration. The management should focus on the exposure to risk concentrations to be prepared for unexpected events that can cause tail risk or spread the total risks.

To manage liquidity means that risks both should be handled in normal and stressed situations. Working with liquidity risk includes the steps; identify, measure, monitor, manage risks, stress testing and communicating the strategy to all levels of the company. The board is responsible for identifying a strategy adapted for the level of liquidity and to communicate it throughout the company [CEBS, 2008].
4 Results

In this section the findings from the empirical and quantitative study are presented. This includes; specifying different types of real estate and their characteristics, risks within different objects, performance measures for real estate and quantifications of de-smoothing, transaction risk and liquidation.

4.1 Real estate investments

All interview participants stated that real estate has historically generated a good risk adjusted return. The historical return from real estate has been good, even compared to stocks. The historically obtained risk measure of volatility have been low, from the available data it is found that in privately owned real estate the standard deviation has been below 8% per year [Valueguard, 2011] compared to stocks which has had a standard deviation of about 17% over the same period. Despite the return not being as good as small cap stocks the lower risk makes real estate having beneficial risk adjusted return [Gavel, 2017], [Fransson, 2017].

The risk adjusted return is not the only reason to invest in real estate; from the interviews it was also found that investors saw value in owning a real asset [Skogestig, 2017]. Real estate is also an attractive investment since it generates a stable cash flow and not only is dependent on the end value [Skogestig, 2017]. When real estate is bought this is typically to get the direct cash flow, which mainly come from rents paid [Salen Broman, 2017]. Other advantages includes differentiation to the portfolio as real estate investments are subject to other risk factors than stocks [Brodin, 2017] but at the same time is a naturally hedge against inflation [Gavel, 2017]. Real estate is also an illiquid investment [Marcato, 2017].

4.1.1 Illiquidity

During the interviews the general opinion on liquidity risk was that this is present in real estate investments. Most interview participants stated that this is a risk they were willing to take in compensation for the liquidity premium they expect to get from real estate assets. Most interview participants believe there is a liquidity premium in the Swedish real estate market, but no one had any quantitative estimate on the size of this premium. A few were skeptical and stated that the liquidity premium is a diffuse term which is hard to quantify [Lekander, 2017], [Fransson, 2017]. As an example Fransson [2017] gave was; a company which is bought out from the public market become less liquid as it exits the market. On the other hand the action of removing the company from the market and therefore becoming more illiquid is not expected to create a higher yield in itself. The example was used to describe the liquidity premium puzzle.

The general fear of illiquidity is limited due to the long investment horizons the investors included in this study have. The investors are knowledgeable about their upcoming cash flows and have a good prognosis with regards to these cash flows [Salen Broman, 2017]. The investors also have a large section of their assets in more liquid assets, this give the investors the possibility of taking on some more illiquid investments [Cameras, 2017].

On the other hand some of the investors were careful and monitored their portfolios liquidity carefully. An example of this is AP3 which internally have limited the
amount they may allocate towards illiquid assets to 25% of their total assets. This
limitation was to prevent problems that could arise with liquidity, if the section of
illiquid assets become to large [Hellström, 2017]. AP1 on the other hand, which has
about 20% allocated to illiquid assets stated that from a liquidity perspective they
could increase the section of illiquid assets to about 50% but that this level of liq-
uidity would impact the diversification in the portfolio in a negative way [Angberg, 2017].

The fact that institutional investors are aware that properties can take time to sell and
markets could fall decreases the effects a potential liquidity crisis would have on their
portfolio. The main risk with illiquidity is when illiquidity arise where it is not expected.
An example of this was during the financial crisis when Lehman brothers went bankrupt
[Brodin, 2017]. During an interview Brodin [2017] said: “When you thought you had
invested in something liquid and then it proved not to be. Here you know it is not”,
referring to real estate. In the interviews it was also brought up that the level of liquidity
differs between segments and expressions like 'liquid- and illiquid real estate’ was men-
tioned in some interviews. The degree of liquidity also differ between objects, not only
between asset classes [Salen Broman, 2017].

4.2 The different sectors of real estate

When talking about real estate it is important to understand what type of real estate
that is being discussed, because of the different characteristics in the different type of real
estate. The IPD-data classify real estate into four main groups; retail, office, residential
and industrial [MSCI, 2016]. MSCI [2016] also have smaller real estate classifications such
as hotels and other but these have not been included in this study. Different types of
real estate have different characteristics in terms of risk and return [Gavel, 2017] and also
how real estate is invested in will impact the assets risk - return profile [Brodin, 2017].
From the interviews we found that regarding direct real estate the highest potential
return comes from investments in commercial real estate, given good timing of the market
cycle [Gavel, 2017]. To commercial real estate industrial, retail and offices are included
[MSCI, 2016]. Residential real estate is more independent of the market as a place to
live is always needed [Brodin, 2017], [Salen Broman, 2017]. Residential real estate have
had the strongest historical development with value increases of up to 40% per year in
nominal terms in the best years since 1987 [IPD, 2013].
It can be seen that all sectors with an exception of residential real estate has developed quite similarly over the time period since 1987, whereas residential real estate has increased a lot more in value over time. Based on the historical return profile residential real estate has offered the best investment option out of the real estate segments [IPD, 2013].

**4.2.1 The valuation based IPD**

The IPD index as is shown in 7 is a valuation based index, as opposed to transaction based indexes. In literature the common understanding is that valuation based indexes get smoothed and show lower volatility than that seen in transactions [Edelstein & Quan, 2006]. The valuation of single real estate objects is simple compared to other unlisted investments or for example private equity [Angberg, 2017]. This is mainly due to the predictability in cash flows, as rental incomes are known in advance and costs can, given a good insurance, be predicted with a high level of accuracy [Angberg, 2017]. The largest source of uncertainty with regards to the valuations is the future occupancy level of the property and future rent levels, both of which are correlated with the market cycle [Gavel, 2017]. All in all individual real estate objects can be valuated quite easily based on traditional cash flow methods under stable or good market conditions [Angberg, 2017], [Cameras, 2017].

**4.2.2 De-smoothing**

The de-smoothing is a method which is used to compensate for the time-lag and smoothing of index values in valuation based indexes. Theory confirm that there is a higher volatility in actual real estate prices than what can be obtained in an index because of the smoothing and lag in valuations [Geltner, 1992]. The de-smoothing process aim to compensate for these problems and can be carried out by using equation 2 in section 3.6.5. The time-lag in valuation based indexes was highlighted during the interviews and also the fund managers had noticed that there could be lags of between three and six months [Fransson, 2017].
The following table presents the behavior of the IPD indexes with both smoothed and de-smoothed volatility:

<table>
<thead>
<tr>
<th>Time period 1987-2016</th>
<th>OMXS30 10 yrs. Gvb</th>
<th>Industrial</th>
<th>Office</th>
<th>Residential</th>
<th>Retail</th>
<th>All Property</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>12.00%</td>
<td>9.08%</td>
<td>12.51%</td>
<td>9.23%</td>
<td></td>
<td>9.23%</td>
</tr>
<tr>
<td>Median</td>
<td>14.21%</td>
<td>7.84%</td>
<td>12.04%</td>
<td>8.96%</td>
<td></td>
<td>7.96%</td>
</tr>
<tr>
<td>Min</td>
<td>-41.74%</td>
<td>-20.87%</td>
<td>-13.18%</td>
<td>-18.5%</td>
<td></td>
<td>-22.98%</td>
</tr>
<tr>
<td>Max</td>
<td>70.96%</td>
<td>40.37%</td>
<td>35.48%</td>
<td>30.69%</td>
<td></td>
<td>38.05%</td>
</tr>
</tbody>
</table>

| Standard deviation    | 26.29%              | 12.21%     | 9.72%  | 9.48%       |        | 11.84%       |
| De-smoothed std (α = 2/3) | -                  | 14.26%    | 11.34% | 11.72%      |        | 13.72%       |
| De-smoothed std (α = 1/2) | -                  | 17.02%    | 13.78% | 14.03%      |        | 16.24%       |

Table 4: Return and standard deviation for different sectors

Source: Data from MSCI-IPD, 2017

A bias in the smoothing compared to the transaction prices is the risk that during bad market periods the actual prices will be lower than seen from the completed transactions. A reason for the transaction prices not giving a full overview of the condition of the market is that fewer transactions are completed. This has been the case in Stockholm as investors have not had an urgent need to sell since the burst of the IT-bubble in the beginning of the 21st-century [Skogestig, 2017].

4.3 INVESTMENT STRUCTURES

The return and volatility of the smoothed and de-smoothed IPD-data in table 4 represent direct investments in their defined segments. As described in the literature review in section 3.4.1 real estate investments can either be conducted directly or indirectly and there are different structures in doing so [Lekander, 2016]. Institutional investors are one of the main actors investing in real estate on the Swedish market [Hellström, 2017]. The large AP-funds are not allowed to directly own real estate and therefore invest only in real estate companies [Fransson, 2017]. Other pension funds on the other hand are allowed
to own real estate directly but this may not be done using leverage [Evander, 2017], [Salen Broman, 2017].

4.3.1 Characteristics

From the interviews it was found that investors are expecting between 4-8% return annually for directly owned real estate. The expected return is dependent on the object and its characteristics and location [Salen Broman, 2017]. Considering a Core real estate object the expected return is just a few percent per year and this is considered as a stable investment which have characteristics similar to that of a bond. Opportunistic real estate investments on the other hand behave more like stocks and have higher risk but also require a higher premium to compensate for the risk [Salen Broman, 2017]. Also the level of liquidity can be connected to the location as seen from the position in the matrix shown in the figure.

4.4 Liquidity risk for single properties

The liquidity of objects vary depending on the characteristics and location of the object [Salen Broman, 2017]. During the interviews the term ‘liquid and illiquid properties’ came up. As liquid real estate objects are Core properties in Central Business Districts (CBD) considered [Cameras, 2017]. Core objects that have a central or unique location are liquid, as in terms of that buyers can be found, even in times of poor market liquidity [Salen Broman, 2017]. The number of potential buyers for an object and the location of the building play an important role for the liquidity of the object [Gavel, 2017]. ”There is only one Biblioteksgatan in Stockholm” [Salen Broman, 2017]. In urban, crowded areas, it is hard to construct new buildings to compete with the existing ones. This can be compared to for example warehouses on the countryside where if someone needs a new warehouse a new can be built as there is not usually a problem to get land [Nyström, 2017]. The location is a factor affecting the ability to sell and make a profit for an investment [Salen Broman, 2017].

Other than the location the way the building is used impact the liquidity of the object. Residential real estate is the most stable and liquid form of real estate investment according to all interviews. This is explained by the demand for housing in urban areas in Sweden, regardless of the condition of the market. The prices will fluctuate but in the long run the value of residential real estate is expected to rise with inflation [Gavel, 2017]. Commercial real estate, for example retail space, is more dependent on the market cycles [Gavel, 2017]. Retail is followed by offices and ware houses when it comes to risk. These two categories have a risk highly dependent on the property, its location and the tenants [Cameras, 2017].
4.4.1 Information imbalance

Some of the investors selected for the interviews only invest in new properties as for older ones there is direct risks with the object such that renovations or repairs may be required. The greater the need for large capital investments the more opportunistic is the object, as the potential up- and downside increase [Salen Broman, 2017]. The risk of unexpected surprises in older properties is reduced by the due diligence process that is conducted on all larger objects before they are traded [Skogestig, 2017]. Reparation cost is a moderate risk for owners and institutions as the costs usually can be put on the part using the building through fees or increased rents. Because of this the risk of renovation cost is a moderate risk as the costs usually can be conveyed on to the tenants [Salen Broman, 2017].

4.4.2 Vacancies

Almost all of the cash flow from real estate comes from rents, either from private persons or companies [Skogestig, 2017]. From the interviews a major risk with real estate was identified as long time vacancies. In attractive locations in Sweden this has not been an issue since the burst of the IT-bubble in the early years of the new century as the demand for space has exceeded the supply as the market has gone up [Skogestig, 2017]. The rent levels are often determined for the duration of the contract, but depending of the conditions in the market once the contract runs out the rent level may change. The occupancy level on the other hand is more directly correlated with the performance of the person or companies renting and then in turn the market cycle. With higher levels of vacancies the cash flow for the object decrease, for this to have a large impact on the over all portfolio return there needs to be quite drastic changes in the market condition [Bergström & Hansen Vikström, 2017].

In new projects there is always a risk that there will be no or low demand for the property once built. This is further increased by the time it takes to complete the project and that it thereby is likely that market conditions change during the building process [Salen Broman, 2017]. In order to combat this issue it is common that objects are built to pre-determined tenants. In residential real estate it is more common that the projects are built on speculation, but due to the law regarding utility rent in Sweden almost all residential real estate built for the rental market in Stockholm will be fully subscripted even before construction start [Gavel, 2017].

It may be harder to find tenants for commercial real estate. This risk is often mediated through rarely building offices on speculation and rather building to a known customer, a pre-rented level of about 60-70% is often enough to in the current market reach a break-even level for the project, given that the budget for the project holds [Bergström & Hansen Vikström, 2017]. This is the most common practice when it comes to office buildings. When it comes to even more specific projects, which is common in logistic or industrial properties the level of speculation in projects is even lower [Gavel, 2017].

Some of the risk with vacancies can be removed through decreasing rent, and in this way keep tenants [Skogestig, 2017]. If there are vacancies there will be lower rental incomes as well as the current rental holders will have a better position for negotiating their rents.
The risk of vacancies can also be decreased by differentiation as the number of tenants increases. A building where the rent is paid by only one company or person carries a higher risk of vacancies than a building with many tenants. This could for example be the case with industrial buildings which only one company is using [Salen Broman, 2017].

4.5 REAL ESTATE AND THE ECONOMIC CYCLE

The risk of vacancies presented in section 4.4.2 is correlated with the market cycle and can therefore be considered to be a market risk. During falling markets or recessions more objects become vacant [Skogestig, 2017]. Real estate is sensitive to changes in the market cycle with varying exposure depending on segment and investment structure [Gavel, 2017]. Commercial real estate as industrial-, office- and retail real estate is more volatile than residential real estate. People need a place to live regardless of the state of the market cycle [Brodin, 2017]. The commercial sectors dependent on the results from the companies renting which is why they tend to be more affected by the market cycle [Cameras, 2017].

How the real estate investments move in relation to the market is also dependent on the selected structure for the investment. Through investing in real estate or real estate companies on the open market the investor faces a lower level of liquidity risk [Salen Broman, 2017]. Assets that are publicly traded will behave more like the market and have a higher correlation to the market. Funds traded off the market and other direct real estate investments follows the real estate market better [Gavel, 2017]. Investing in real estate stocks, the development is more like stocks and less like the underlying and have a higher volatility than other real estate assets. This can for example be seen in the value of noted companies such as Fabege, which is a real estate firm investing in offices in the Stockholm area. Fabeges historical volatility is 15% which is comparatively higher than the volatility of real estate indexes. From interviews we found that the comparatively higher volatility was explained by stocks in public real estate firms also being subject to reactions in the market and thereby subject to market volatility [Ang, 2014], [Evander, 2017].

4.5.1 DIVERSIFICATION

From the interviews it was found that another main reasons to include real estate in a portfolio was because of the beneficial correlation between real estate and stocks or bonds. When building a portfolio it is desirable to have a low correlation between the assets to minimize the risk in the portfolio without giving up too much of the potential return [Berk & DeMarzo, 2014].

Correlation between stocks and real estate vary drastically over time, as seen in the graph below. In this graph the rolling 12 month correlation between HOX-All Sweden to bonds and stocks is shown. The index RXVX represents Swedish treasury bills and OMXS30 is the index for the 30 largest stocks on the Swedish stock market.
As can be seen in figure 10 the correlation between real estate and stocks or bonds has varied over time. During some periods the correlation to stocks has been noticeably negative which is a desirable trait [Berk & DeMarzo, 2014]. During the 2008-2009 crisis the correlation increased, which is bad for the portfolio diversification, as both real estate and stocks fell in value. On the other hand the correlation between Swedish treasury bills and residential real estate generate very low correlation during the financial crisis around year 2008.

4.5.2 Interest rate risk

Real estate assets often require external financing from for example banks. This will for obvious reasons lead to an exposure towards interest rates as the cost for the financing increase with higher interest rates. The use of external financing is a factor which generate leverage and thereby may increase the return from an asset. With or without leverage real estate investments tend to be sensitive to increases in the interest rate levels, and interest rate risk is considered one of the major risk factors [Bergström & Hansen Vikström, 2017], [Salen Broman, 2017], [Hellström, 2017]. This is of particular importance due to the low interest levels that is currently (2017) seen in Sweden. This makes the likelihood of further decreasing interest rates low compared to the probability of increasing interest rate levels [Bergström & Hansen Vikström, 2017]. This creates a risk from the interest rate perspective, interest rates would however have to increase substantially for this to have a large impact, for example did Bergström and Hansen Vikström [2017] state that they 5% interest rate would be considered a high rate for them.

4.5.3 Transactions and the economic cycle

The liquidity risk that real estate assets bring to a portfolio is mostly a problem during times of bad market conditions. In a flourishing economy almost anything can be sold and the level of liquidity rise in the market [Salen Broman, 2017]. In bad markets
no or few transactions are completed and there is then no market to trade less liquid investments as for example real estate [Skogestig, 2017]. In a diminishing market most pressure is on actors which have taken on bad investments or taken high risks with potentially high leverage [Gavel, 2017]. On the Swedish market, actors are prepared for peridical drops in real estate investments. The actors with large quantities of real estate are large with stable balance sheets and long investment horizons. Their stable balance sheets decreases their potential need to sell during negative market times [Hellström, 2017].

Another aspect that Gavel [2017] brought up was that banks and companies do not want the valuations to go down on properties and there is therefore a risk of investors exchanging properties between investors to show up higher prices then the actual market values. This could pose a valuation risk as transactions shown could not be trusted. The most common way to value a portfolio is to use a benchmark index, and use this for comparison to which statistical methods can be applied and values under varying market conditions extracted. These indexes are usually valuation based and updated on a annual or quarterly basis which may further contribute to the problem with time lag or smoothed valuations. The indexes which can be used for estimating the value of the portfolios is not always representative for the objects that are in the portfolio [Angberg, 2017]. More transactions in comparable objects would make valuations and transactions easier to validate, but because of the limited stock of objects and fewer transactions during recession this data is not always available [Skogestig, 2017].

4.5.4 Lock in effect

A scenario with a falling market where no or few transactions take place may cause worries for a lock in. According to Brodin [2017] investors fear to get locked into an asset and thereby have limited ability to invest in opportunities that may arise in the future. This risk is large with real estate assets due to the long investment horizon of this asset class. Making bad investment decisions are always a risk but the alternative to not make any investments and wait for an opportunity is not an option [Brodin, 2017]. One way of handling the lock in effect when buying real estate as structured products with a duration, suggested by Brodin [2017], is to buy small portions yearly and then eventually create a portfolio with possibility to exit more frequently.

4.6 Transaction risk

The transaction risk which is part of the liquidity risk can be calculated using the ex-ante formula presented in section 3.6.7. In table 7 different scenarios for the scaling factor for liquidity is shown. This is dependent on the expected holding period and transaction period.

4.6.1 Transaction and holding period

To decide the transaction period Hordijk and Teubens [2008] steps in the transaction process described in section 3.6 can be used to give a better estimation of the time and compare answers from interviews with what is used in the formula. The transaction period used in the ex-ante formula is measured from the time of a decision to sell an asset to the completion of the trade. This means that the transaction period does not only
include the time it takes to transfer the cash but also the pre-marketing-, marketing- and due diligence period.

From the interviews the time from the point of getting in contact with a potential buyer to the completion of the trade can be estimated to take between three to six months for direct real estate investments. In table 5 the answers from respective interview has been summarized. The interval is close to that found by Hordijk and Teuben [2008] who found the transaction period in Britain lasts between two and six months. This is under the presumption that the trade is successful. The success of the trade depend on the market cycle and not all trades are successful and an asset can instead be removed from the market. The unsuccessful transactions can not be seen in the statistics [Cameras, 2017]. For successful trades the time it takes to sell an asset is dependent on the number of potential buyers for the objects given the present market conditions and the characteristics of the object. For larger properties more time is usually invested to make an interesting case and attract more buyers which means that the transaction time is usually longer for larger objects [Skogestig, 2017].

The following table represent the summarized answers regarding expected transaction and holding periods from the interview participants:

<table>
<thead>
<tr>
<th>Name</th>
<th>Company</th>
<th>Holding period</th>
<th>Transaction period</th>
</tr>
</thead>
<tbody>
<tr>
<td>J. Skogestig</td>
<td>Vasakronan</td>
<td>Infinity</td>
<td>3-6 months</td>
</tr>
<tr>
<td>B. Hellström</td>
<td>AP3</td>
<td>Infinity</td>
<td>3 months</td>
</tr>
<tr>
<td>R. Gavel</td>
<td>SEB</td>
<td>8 yrs</td>
<td>6 months</td>
</tr>
<tr>
<td>F. Salen Bronman</td>
<td>SEB</td>
<td>Long</td>
<td>2-3 months</td>
</tr>
<tr>
<td>M. Cameras</td>
<td>AMF</td>
<td>Infinity</td>
<td>&gt;3 months, &lt;1 yr</td>
</tr>
<tr>
<td>Å. Bergström</td>
<td>Fabege</td>
<td>Infinity</td>
<td>-</td>
</tr>
<tr>
<td>M. Angberg</td>
<td>AP1</td>
<td>Infinity</td>
<td>-</td>
</tr>
<tr>
<td>T. Fransson</td>
<td>AP4</td>
<td>Long</td>
<td>6 months</td>
</tr>
<tr>
<td>O. Nyström</td>
<td>AP4</td>
<td>Long</td>
<td>6 months</td>
</tr>
<tr>
<td>A. Evander</td>
<td>FPK</td>
<td>Infinity</td>
<td>3-6 months</td>
</tr>
</tbody>
</table>

Table 5: Summary of investment assumptions

Most interview participants claim to have no end date for real estate investments and assume that these will be in the portfolios forever. When valuating properties usually a ten year time horizon is used even though no fixed time horizon is decided before hand [Skogestig, 2017]. However, some of the interview participants had fixed end dates for their real estate investments due to the structures of their funds. Pension funds have long time horizons in their investments as liabilities are far into the future [Hellström, 2017]. Out of the investors with limited horizons, one was a real estate fund with duration of eight years, the other one a pension fund closing down.

From the institutionally owned properties represented in the IPD database the results for the implied holding period can be seen in table 6. The average holding period for all properties is 12 years. Offices and retail have the highest average implied holding period with 16 years. During the period between 2005 and 2012 very few trades were completed in all categories. In 2008 no institutionally owned real estate included in the IPD database was traded. It can be seen that before the period 2005-2012 real estate
were held for shorter time periods than what is implied during the last four years.

Table 6: Implied holding period

<table>
<thead>
<tr>
<th>Year</th>
<th>01</th>
<th>02</th>
<th>03</th>
<th>04</th>
<th>05</th>
<th>06</th>
<th>07</th>
<th>08</th>
<th>09</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>All properties</td>
<td>4</td>
<td>7</td>
<td>5</td>
<td>10</td>
<td>9</td>
<td>9</td>
<td>10</td>
<td>17</td>
<td>14</td>
<td>19</td>
<td>14</td>
<td>21</td>
<td>13</td>
<td>10</td>
<td>16</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Industrial</td>
<td>5</td>
<td>4</td>
<td>6</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td>32</td>
<td>19</td>
<td>14</td>
<td>23</td>
<td>14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Office</td>
<td>5</td>
<td>9</td>
<td>6</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td>29</td>
<td>15</td>
<td>24</td>
<td>25</td>
<td>16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residential</td>
<td>4</td>
<td>6</td>
<td>4</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td>19</td>
<td>29</td>
<td>22</td>
<td></td>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retail</td>
<td>5</td>
<td>9</td>
<td>6</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td>29</td>
<td>15</td>
<td>24</td>
<td>25</td>
<td>16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*The blank spaces are due to the implied formula (3) of holding periods. During years with no sales the implied holding period can not be calculated, as this is the denominator in the formula.

4.6.2 Ex-ante variance HOX

For the initial calculation of ex-ante variance HOX-index was used, as HOX is transaction based no de-smoothing had to be conducted. The HOX-index is available on monthly basis from January 2005 until December 2016 for this study. The ex-ante scaling below is based on monthly transaction period and holding period, the mean and variance factors in the input is also in monthly form.

Table 7: Ex-ante scaling HOX 2005-2016

<table>
<thead>
<tr>
<th>Holding period</th>
<th>1</th>
<th>6</th>
<th>12</th>
<th>24</th>
<th>60</th>
<th>120</th>
<th>182</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transaction period</td>
<td>1.066</td>
<td>1.019</td>
<td>1.010</td>
<td>1.005</td>
<td>1.002</td>
<td>1.001</td>
<td>1.001</td>
</tr>
<tr>
<td>3</td>
<td>1.296</td>
<td>1.131</td>
<td>1.079</td>
<td>1.044</td>
<td>1.019</td>
<td>1.010</td>
<td>1.006</td>
</tr>
<tr>
<td>6</td>
<td>1.676</td>
<td>1.394</td>
<td>1.263</td>
<td>1.158</td>
<td>1.072</td>
<td>1.038</td>
<td>1.025</td>
</tr>
<tr>
<td>10</td>
<td>2.195</td>
<td>1.821</td>
<td>1.597</td>
<td>1.387</td>
<td>1.188</td>
<td>1.101</td>
<td>1.068</td>
</tr>
<tr>
<td>12</td>
<td>2.456</td>
<td>2.051</td>
<td>1.789</td>
<td>1.526</td>
<td>1.263</td>
<td>1.143</td>
<td>1.098</td>
</tr>
<tr>
<td>15</td>
<td>2.848</td>
<td>2.408</td>
<td>2.095</td>
<td>1.758</td>
<td>1.394</td>
<td>1.219</td>
<td>1.150</td>
</tr>
<tr>
<td>20</td>
<td>3.503</td>
<td>3.022</td>
<td>2.643</td>
<td>2.195</td>
<td>1.657</td>
<td>1.376</td>
<td>1.260</td>
</tr>
<tr>
<td>24</td>
<td>4.028</td>
<td>3.523</td>
<td>3.103</td>
<td>2.577</td>
<td>1.901</td>
<td>1.526</td>
<td>1.367</td>
</tr>
<tr>
<td>60</td>
<td>8.756</td>
<td>8.169</td>
<td>7.571</td>
<td>6.633</td>
<td>4.943</td>
<td>3.629</td>
<td>2.955</td>
</tr>
</tbody>
</table>

The scaling factor in the table presents the transaction risk which is part of the illiquidity risk and can not be measured using volatility. To better estimate the risk of real estate investments the factor should therefore be used to multiple the obtained variance. In table 7 it can be seen that the ex-ante scaling factor increase as the transaction period in proportion to the holding period increases.

In the table below a summary of the 6 months transaction period 120 months holding period for each division of the HOX-index can be seen. The use of six months transaction period is selected to represent the approximate transaction period found from the interviews, the 120 month holding period as benchmark was selected to match the calculation horizon of Vasakronan. The table is based on annual return and annual standard deviation.
<table>
<thead>
<tr>
<th>Index</th>
<th>Annual return</th>
<th>St. dev</th>
<th>Scaling factor</th>
<th>Scaled St. dev</th>
<th>Sharpe ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Sweden</td>
<td>7.3%</td>
<td>5.6%</td>
<td>1.038</td>
<td>5.7%</td>
<td>0.827</td>
</tr>
<tr>
<td>Flats Sweden</td>
<td>9.8%</td>
<td>6.2%</td>
<td>1.054</td>
<td>6.4%</td>
<td>1.130</td>
</tr>
<tr>
<td>Flats Stockholm</td>
<td>9.6%</td>
<td>7.2%</td>
<td>1.038</td>
<td>7.4%</td>
<td>0.954</td>
</tr>
<tr>
<td>Flats Gothenburg</td>
<td>10.7%</td>
<td>7.0%</td>
<td>1.050</td>
<td>7.2%</td>
<td>1.133</td>
</tr>
<tr>
<td>Flats Malmö</td>
<td>7.8%</td>
<td>8.0%</td>
<td>1.021</td>
<td>8.0%</td>
<td>0.654</td>
</tr>
<tr>
<td>Flats other cities</td>
<td>10.3%</td>
<td>5.9%</td>
<td>1.065</td>
<td>6.1%</td>
<td>1.262</td>
</tr>
<tr>
<td>Houses Sweden</td>
<td>6.4%</td>
<td>6.2%</td>
<td>1.023</td>
<td>6.3%</td>
<td>0.605</td>
</tr>
<tr>
<td>Houses Stockholm</td>
<td>7.1%</td>
<td>7.4%</td>
<td>1.020</td>
<td>7.5%</td>
<td>0.606</td>
</tr>
<tr>
<td>Houses Gothenburg</td>
<td>7.0%</td>
<td>7.7%</td>
<td>1.018</td>
<td>7.8%</td>
<td>0.570</td>
</tr>
<tr>
<td>Houses Malmö</td>
<td>5.1%</td>
<td>7.9%</td>
<td>1.009</td>
<td>7.9%</td>
<td>0.318</td>
</tr>
<tr>
<td>Houses other cities</td>
<td>6.1%</td>
<td>7.1%</td>
<td>1.017</td>
<td>7.1%</td>
<td>0.495</td>
</tr>
<tr>
<td>SBX</td>
<td>11.9%</td>
<td>17.0%</td>
<td>-</td>
<td>-</td>
<td>0.551</td>
</tr>
<tr>
<td>OMXS 30</td>
<td>7.5%</td>
<td>17.3%</td>
<td>-</td>
<td>-</td>
<td>0.285</td>
</tr>
<tr>
<td>10 yrs. Gvt. Bond</td>
<td>2.5%</td>
<td>1.2%</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

As can be seen in the table above, residential real estate has over the last 11 years outperformed OMXS30 in terms of Sharpe ratio, this is mainly explained by the higher volatility associated with stocks rather than real estate as the two asset classes has quite similar average annual return. Over the period flats in other cities than the three metropolitan areas in Sweden have given the highest risk adjusted return after adjusting for the transaction period risk. In this measure it should be noted that only successful trades are reported and there are rural areas where there is hard to find buyers which could be a potential bias for this measurement. Single family homes in Malmö yielded the lowest risk adjusted return after transaction period risk was included, the risk adjusted return is however still greater than that of OMXS30.

### 4.6.3 Ex-ante variance of IPD index All Property

The data from the IPD:s category of 'All property' in general give low scaling factors. The scaling factors in the table shows that the volatility should be increased by a factor of 1.013 assuming a holding period of ten years and a transaction time of six months, if smoothed data is used. In the first two tables original data, prior to de-smoothing is used. In the two following tables de-smoothed data with $\alpha = 0.5$ has been used.
Table 9: Ex-ante scaling IPD All Property 1987-2016

<table>
<thead>
<tr>
<th>Holding period</th>
<th>Transaction period</th>
<th>1</th>
<th>6</th>
<th>12</th>
<th>24</th>
<th>60</th>
<th>120</th>
<th>182</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>1.023</td>
<td>1.007</td>
<td>1.004</td>
<td>1.002</td>
<td>1.001</td>
<td>1.000</td>
<td>1.000</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1.105</td>
<td>1.047</td>
<td>1.028</td>
<td>1.016</td>
<td>1.007</td>
<td>1.003</td>
<td>1.002</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>1.240</td>
<td>1.140</td>
<td>1.093</td>
<td>1.056</td>
<td>1.025</td>
<td>1.013</td>
<td>1.009</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>1.424</td>
<td>1.292</td>
<td>1.212</td>
<td>1.137</td>
<td>1.067</td>
<td>1.036</td>
<td>1.024</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>1.517</td>
<td>1.373</td>
<td>1.280</td>
<td>1.187</td>
<td>1.093</td>
<td>1.051</td>
<td>1.035</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>1.656</td>
<td>1.500</td>
<td>1.389</td>
<td>1.269</td>
<td>1.140</td>
<td>1.078</td>
<td>1.053</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>1.889</td>
<td>1.718</td>
<td>1.583</td>
<td>1.424</td>
<td>1.233</td>
<td>1.133</td>
<td>1.092</td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>2.075</td>
<td>1.896</td>
<td>1.747</td>
<td>1.560</td>
<td>1.320</td>
<td>1.187</td>
<td>1.130</td>
</tr>
<tr>
<td></td>
<td>60</td>
<td>3.754</td>
<td>3.545</td>
<td>3.333</td>
<td>3.000</td>
<td>2.400</td>
<td>1.933</td>
<td>1.694</td>
</tr>
</tbody>
</table>

Just like in table 7 the results in table 9 show that the longer the expected holding period the smaller the ex-ante scaling factor and the longer the expected transaction period the larger the ex-ante scaling factor. This means that the longer the transaction period in comparison to the holding period the greater the transaction period risk [Bond & Huang, 2004].

Table 10: Summary of return and volatility, years 1987-2016

<table>
<thead>
<tr>
<th>Index</th>
<th>Annual return</th>
<th>St. dev</th>
<th>Scale factor</th>
<th>Scaled st.dev</th>
<th>Scaled Sharpe ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>All property</td>
<td>9.2%</td>
<td>11.8%</td>
<td>1.013</td>
<td>12.0%</td>
<td>0.278</td>
</tr>
<tr>
<td>Industrial</td>
<td>9.1%</td>
<td>12.2%</td>
<td>1.020</td>
<td>12.4%</td>
<td>0.255</td>
</tr>
<tr>
<td>Office</td>
<td>8.8%</td>
<td>12.9%</td>
<td>1.016</td>
<td>13.1%</td>
<td>0.221</td>
</tr>
<tr>
<td>Residential</td>
<td>12.5%</td>
<td>9.7%</td>
<td>1.046</td>
<td>10.2%</td>
<td>0.650</td>
</tr>
<tr>
<td>Retail</td>
<td>9.2%</td>
<td>9.9%</td>
<td>1.012</td>
<td>10.1%</td>
<td>0.331</td>
</tr>
<tr>
<td>OMXS30</td>
<td>12.0%</td>
<td>26.3%</td>
<td>-</td>
<td>-</td>
<td>0.232</td>
</tr>
<tr>
<td>10 Y Gvt Bond</td>
<td>5.9%</td>
<td>3.6%</td>
<td>-</td>
<td>-</td>
<td>0.331</td>
</tr>
</tbody>
</table>

In the table above it can be seen that all Sharpe ratios are of about the same scale for the smoothed data and OMXS30, with an exception of residential real estate. As Sharpe ratio is a measurement of risk adjusted return, having Sharpe ratios corresponding to that of stocks should be an indicator that the risk taken when investing in an asset is rewarded with the current level of average return [Sharpe, 1964].
Table 11: Ex-ante scaling IPD All Property 1987-2016, de-smoothed ($\alpha = 0.5$)

<table>
<thead>
<tr>
<th>Transaction period</th>
<th>1</th>
<th>6</th>
<th>12</th>
<th>24</th>
<th>60</th>
<th>120</th>
<th>182</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.012</td>
<td>1.004</td>
<td>1.002</td>
<td>1.001</td>
<td>1.000</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1.056</td>
<td>1.025</td>
<td>1.015</td>
<td>1.008</td>
<td>1.004</td>
<td>1.002</td>
<td>1.001</td>
</tr>
<tr>
<td>6</td>
<td>1.128</td>
<td>1.074</td>
<td>1.050</td>
<td>1.030</td>
<td>1.014</td>
<td>1.007</td>
<td>1.005</td>
</tr>
<tr>
<td>10</td>
<td>1.225</td>
<td>1.155</td>
<td>1.113</td>
<td>1.073</td>
<td>1.035</td>
<td>1.019</td>
<td>1.013</td>
</tr>
<tr>
<td>12</td>
<td>1.275</td>
<td>1.198</td>
<td>1.149</td>
<td>1.099</td>
<td>1.050</td>
<td>1.027</td>
<td>1.018</td>
</tr>
<tr>
<td>15</td>
<td>1.349</td>
<td>1.266</td>
<td>1.207</td>
<td>1.143</td>
<td>1.074</td>
<td>1.041</td>
<td>1.028</td>
</tr>
<tr>
<td>20</td>
<td>1.472</td>
<td>1.382</td>
<td>1.310</td>
<td>1.225</td>
<td>1.124</td>
<td>1.071</td>
<td>1.049</td>
</tr>
<tr>
<td>24</td>
<td>1.572</td>
<td>1.476</td>
<td>1.397</td>
<td>1.298</td>
<td>1.170</td>
<td>1.099</td>
<td>1.069</td>
</tr>
<tr>
<td>60</td>
<td>2.464</td>
<td>2.353</td>
<td>2.240</td>
<td>2.063</td>
<td>1.744</td>
<td>1.496</td>
<td>1.369</td>
</tr>
</tbody>
</table>

Compared to table 9 it is seen that the scaling factors are lower when using de-smoothed data as in table 11. The same pattern of increasing scaling factors towards the lower left hand corner of the matrix does remain.

Table 12: Summary of return and volatility, years 1987-2016, de-smoothed ($\alpha = 0.5$)

<table>
<thead>
<tr>
<th>Index</th>
<th>Annual return</th>
<th>St. dev</th>
<th>St. dev ($\alpha = 0.5$)</th>
<th>Scale factor</th>
<th>Scaled st.dev</th>
<th>Scaled Sharpe ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>All property</td>
<td>9.2%</td>
<td>11.8%</td>
<td>16.2%</td>
<td>1.007</td>
<td>16.3%</td>
<td>0.204</td>
</tr>
<tr>
<td>Industrial</td>
<td>9.1%</td>
<td>12.2%</td>
<td>17.0%</td>
<td>1.006</td>
<td>17.1%</td>
<td>0.186</td>
</tr>
<tr>
<td>Office</td>
<td>8.8%</td>
<td>12.9%</td>
<td>17.6%</td>
<td>1.005</td>
<td>17.7%</td>
<td>0.165</td>
</tr>
<tr>
<td>Residential</td>
<td>12.5%</td>
<td>9.7%</td>
<td>13.8%</td>
<td>1.018</td>
<td>13.9%</td>
<td>0.475</td>
</tr>
<tr>
<td>Retail</td>
<td>9.2%</td>
<td>9.9%</td>
<td>14.0%</td>
<td>1.009</td>
<td>14.1%</td>
<td>0.236</td>
</tr>
<tr>
<td>OMXS30</td>
<td>12.0%</td>
<td>26.3%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.232</td>
</tr>
<tr>
<td>10Y Gvt Bond</td>
<td>5.9%</td>
<td>3.6%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 12 show the scaling factor for different sectors in the IPD index, when de-smoothing with $\alpha = 0.5$ is applied to the data, other de-smoothing levels has been tested but only $\alpha = 0.5$ will be shown in this report. The scaling factor is calculated as what would be obtained from a ten year holding period and six month expected transaction period time. Comparing the different sectors in the IPD index the scaling factor is highest in residential property and lowest for offices. The de-smoothing of the indexes increases the standard deviation with about 40% but through using de-smoothed data when calculation the ex-ante scaling factor, it is seen that the factor decreases in comparison to the factor obtained for the un-adjusted time series. Overall lower estimations for the Sharpe ratio were observed when de-smoothed data is used, this is expected as the standard deviation is higher prior to the scaling.

The rescaling of the standard deviation and the movement this causes for the risk-return ratio can be seen in figure 11.
4.6.4 Ex-ante variance, IPD and HOX comparison

It needs to be noted that the IPD-data is based on the time period 1987 - 2016 whereas the HOX index is available for the time period 2005 - 2016. It should also be noted that the volatility scaling for the category of all property is used for IPD and the HOX index includes only residential real estate. These two differences means that comparisons have to be handled with caution and for this reason no direct comparisons in either graphs or table are figuring in this study. Instead a more general discussions is carried out of the findings.

In the figure below the risk and return profile, scaled for de-smoothing and ex-ante variance for IPD data compared to OMX30 and government bond returns can be seen.
As can be seen in figure 12 the risk return profile seem to fit quite well in the risk-return spectrum between stocks and bonds. This does not hold for HOX-index as can be seen in the figure 13, it can also be seen that OMXS30 has had a fairly low return compared to Stockholm Benchmark Index (SBX) which also include smaller stocks.

It is quite noticeable that most of the sub-indexes included in HOX have a risk-return profile higher than that of OMXS30. This would imply that the risk adjusted return for investing in residential real estate is higher than that of large cap stocks, however the risk adjusted return is just slightly higher than that of SBX, which is the Stockholm benchmark index. Residential real estate in the IPD-data give higher risk adjusted return than OMXS30. The risk adjusted return after scaling for ex-ante variance is still higher.
for residential real estate than for stocks which would imply, under the efficient market hypothesis [Malkiel, 1989], that there are some risks that are not known to all traders, as it should not be possible to trade with arbitrage or gain excessive returns.

4.6.5 Transaction premium

From the Sharpe ratio for stocks and 10 year government bond the return which should be allocated to the transaction process risk was calculated. In the column 'Transaction process premium (de-smoothed)' the time series is de-smoothed with parameter $\alpha = 0.5$ prior to the ex-ante scaling factor was calculated.

Table 13: Transaction process premium for IPD 1987-2016

<table>
<thead>
<tr>
<th>Sector</th>
<th>Transaction process premium (de-smoothed)</th>
<th>Transaction process premium</th>
</tr>
</thead>
<tbody>
<tr>
<td>All property</td>
<td>0.015%</td>
<td>0.043%</td>
</tr>
<tr>
<td>Industrial</td>
<td>0.014%</td>
<td>0.064%</td>
</tr>
<tr>
<td>Office</td>
<td>0.013%</td>
<td>0.056%</td>
</tr>
<tr>
<td>Residential</td>
<td>0.032%</td>
<td>0.119%</td>
</tr>
<tr>
<td>Retail</td>
<td>0.018%</td>
<td>0.032%</td>
</tr>
</tbody>
</table>

As can be seen above the liquidity premium which can be allocated to the transaction process risk is low for all sectors. For the sector residential the premium is higher than for other sectors. It is however important to notice that the Sharpe ratio from this sector does not correspond to that of liquid asset classes which indicate that there are other risk factors present for residential real estate which is not visible in the transaction process premium.

In the table below the transaction process premium for HOX has been summarized.

Table 14: Transaction process premium for HOX 2005-2016

<table>
<thead>
<tr>
<th>Sector</th>
<th>Transaction process premium</th>
<th>Sector</th>
<th>Transaction process premium</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Sweden</td>
<td>0.047%</td>
<td>Houses Sweden</td>
<td>0.033%</td>
</tr>
<tr>
<td>Flats Sweden</td>
<td>0.074%</td>
<td>Houses Stockholm</td>
<td>0.034%</td>
</tr>
<tr>
<td>Flats Stockholm</td>
<td>0.062%</td>
<td>Houses Gothenburg</td>
<td>0.032%</td>
</tr>
<tr>
<td>Flats Gothenburg</td>
<td>0.078%</td>
<td>Houses Malmo</td>
<td>0.017%</td>
</tr>
<tr>
<td>Flats Malmo</td>
<td>0.038%</td>
<td>Houses other cities</td>
<td>0.026%</td>
</tr>
<tr>
<td>Flats other cities</td>
<td>0.085%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

As can be seen from the table above the risk premium which should be allocated to the transaction process risk for HOX index is of about the same magnitude as the transaction process risk for the de-smoothed IPD index. However, these indexes does, just like the sector ‘residential’ from IPD not generate Sharpe ratios on par with that of stocks.
4.7 Time horizon and transaction costs

When considering an investment, the time horizon for the investment is an important aspect, especially when it comes to assets with high transaction cost such as real estate. When there are high transaction costs this needs to be accounted for in the pricing and in the intended holding period. Which follow form the liquidity discount described in section 3.5. An asset with a lower transaction cost but which is traded more frequently could in the long run have the same total transaction cost as an investment with a long holding period and high transaction costs [Lekander, 2017].

In larger real estate objects the transaction cost is relatively fixed no matter of the final transaction price. The process of buying or selling costs almost the same for an equivalent building in a unattractive area with lower value as for an attractive area [Skogestig, 2017]. This is because of the steps that the transaction process goes through. For a proper examination of an object decreasing the risk of the trade there are several steps that have to be gone through. As a buyer these steps include hiring a lawyer, financial-, technical- and environmental due-diligence, valuations and potentially getting loan agreements [Gavel, 2017]. Because of the relatively fixed cost independent of the value of the house the transaction cost can range between 0.5% to 5% for larger transactions [Skogestig, 2017]. Most of these costs are dependent on the need to hire consultants to help with the transaction, if these skills are available in-house the transaction cost from the sellers side can be reduced to just a few basis points, but this in terms increase the company costs [Bergström & Hansen Vikström, 2017].

4.8 Forced sales

A situation of forced sales could be caused by; demand for cash to a different investment, a drop in value of other asset classes, changes in regulation which the particular fund is obliged to follow or that a new management has different views on how to best invest the capital amongst many factors. Being forced to sell an asset can lead to lower sales price as fewer actor will have time to act or make the required decisions [Donner et al., 2016], [Campbell et al., 2011]. A downside with being forced to sell an asset is that it is likely that the investor will not have sufficient time to market the asset. As seen in the literature review of section 3.7 the estimated value decrease in a situation of forced sales is between 20 and 30% [Donner et al., 2016]. The total effect of the expected accumulated return is large if the risk of forced sale is included.
In the figure above the expected accumulated return can be seen for two assets with an annual return of 7.3% which is the historical average return for HOX all Sweden. The investor has got a risk of fire sale of 2% per year and a cost in case of fire sale of 20% of the accumulated value at the time of the sale, which is in the lower spectrum of empirical value decrease [Donner et al., 2016]. These scenarios are based on a general case and needs to be adjusted depending on the funds risk and structure.

As can be seen in the graph above the risk of fire sale has got a large impact on the expected return. If the lock in period is 10 years in the set up described above the second asset is required to generate 8.25% return per year to generate the same expected return as the asset with no risk of fire sale. However, if the lock in period is 30 years and the other assumptions the same, the required compensation is 8.87%. This shows that the risk with fire sale increase with longer expected holding period, given constant annual risk of fire sale.

4.8.1 Liquidation premium

The need of selling a property immediately can be represented by the liquidation premium seen as the return bias in the following table. The liquidation bias is the inability of obtaining full market price when a trade has to take place immediately [Lin & Vandell, 2007]. The market return and volatility is what will be obtained by the seller for different marketing periods. A marketing period of six months would for the seller imply a negative return of 1% and the liquidation premium is in this case 10.3%.
Table 15: Liquidation premium IPD, all property 1987-2016

<table>
<thead>
<tr>
<th>Months</th>
<th>Market return</th>
<th>Market volatility</th>
<th>Return bias</th>
<th>Volatility bias</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>9.2%</td>
<td>11.8%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>2</td>
<td>5.8%</td>
<td>13.8%</td>
<td>3.4%</td>
<td>2.0%</td>
</tr>
<tr>
<td>4</td>
<td>2.4%</td>
<td>15.8%</td>
<td>6.8%</td>
<td>3.9%</td>
</tr>
<tr>
<td>6</td>
<td>-1.0%</td>
<td>17.8%</td>
<td>10.3%</td>
<td>5.9%</td>
</tr>
<tr>
<td>8</td>
<td>-4.4%</td>
<td>19.7%</td>
<td>13.7%</td>
<td>7.9%</td>
</tr>
<tr>
<td>10</td>
<td>-7.9%</td>
<td>21.7%</td>
<td>17.1%</td>
<td>9.9%</td>
</tr>
<tr>
<td>12</td>
<td>-11.3%</td>
<td>23.7%</td>
<td>20.5%</td>
<td>11.8%</td>
</tr>
</tbody>
</table>

Correspondingly for the HOX-index representing residential real estate, the return bias is 4.8% and volatility bias 2.8% for a house owner being forced to sell immediately.

Table 16: Liquidation premium HOX 2005-2016

<table>
<thead>
<tr>
<th>Months</th>
<th>Market return</th>
<th>Market volatility</th>
<th>Return bias</th>
<th>Volatility bias</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>7.3%</td>
<td>5.6%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>2</td>
<td>5.7%</td>
<td>6.5%</td>
<td>1.6%</td>
<td>0.9%</td>
</tr>
<tr>
<td>4</td>
<td>4.1%</td>
<td>7.5%</td>
<td>3.2%</td>
<td>1.9%</td>
</tr>
<tr>
<td>6</td>
<td>2.5%</td>
<td>8.4%</td>
<td>4.8%</td>
<td>2.8%</td>
</tr>
<tr>
<td>8</td>
<td>0.8%</td>
<td>9.3%</td>
<td>6.5%</td>
<td>3.7%</td>
</tr>
<tr>
<td>10</td>
<td>-0.8%</td>
<td>10.3%</td>
<td>8.1%</td>
<td>4.7%</td>
</tr>
<tr>
<td>12</td>
<td>-2.4%</td>
<td>11.2%</td>
<td>9.7%</td>
<td>5.6%</td>
</tr>
</tbody>
</table>

4.8.2 Real estate as security

Forced sales is in literature review seen as an essential risk linked to liquidity. Generally an advantage with owning property with space to take out loans, is that the owner can take a loan with the real estate as security in case of need for liquidity, rather than being forced to sell the asset. This option is used by unions in Sweden. They hold real estate and use these as security to take out loans in case of strikes or other costly conflicts that may arise [Anveden, 2017].

The same use of real estate is not possible for pension funds as they are not allowed to leverage their real estate assets under current regulatory structures. It is however, legal to bundle real estate and form a subsidiary real estate firm which own all real estate assets which then in turn can leverage the real estate assets. The subsidiaries can take out loans to get liquidity without having to sell the underlying asset. The use of real estate firms holding the real estate and then fund these in turn is seen on the market, an example is the AP-funds which are not allowed to directly own real estate and therefore invest in real estate companies [Fransson, 2017]. For other pension funds which hold their real estate directly it would be both time consuming and expensive to set up this kind of solution if there is a unexpected demand for cash [Salen Broman, 2017].
4.9 Institutional investors inclusion of real estate

There can be different objectives behind the decision to include real estate in a portfolio. Depending on the strategy behind including alternative investments also the structure of the rest of the portfolio needs to be taken into consideration [Brodin, 2017]. The allocation of real estate differed between the pension funds both in size and structure. Many smaller institutional investors today have allocations of less than five percent to direct real estate [Brodin, 2017]. Other funds included also real estate companies and some of the stocks to the category and then reach an allocation of about 20% [Svensk försäkring, 2017]. A problem with these numbers is however that the definition of what is included in real estate vary depending on the fund and there are no clear guidelines on what should be included in the asset class 'real estate' [Gustavsson, 2017].

4.9.1 Capital structure and ALM

For institutional investors with long time horizons and known debts at future points, investors search to find investments with similar performance as time horizons to match there liability and thereby get a natural hedge. For pension funds part of the dept can be cash flows 30 or 40 years in the future, future payments are discounted with the interest rate curve. To hedge the future payment investors want to have products that follow interests with this long duration, whereas government bonds usually have duration time of 15 years maximum. This creates a duration risk in the portfolio and investors are often trying to use interest rates swaps to get a longer duration [Salen Broman, 2017].

Investments with long duration that moves with interest levels are therefore interesting for pension funds as they offer good hedge of the liability. From an ALM perspective there could be a reason of including real estate investments as these have a long time horizon and the prices follows the inflation. Investing in Core real estate assets the stable yield and the lower degree of liquidity risk in comparison to other real estate classes makes it interesting to act as bonds to gain a stable cash flow [Salen Broman, 2017].

4.9.2 Size matters

Forming an illiquid portfolio takes time and it also requires the portfolio to be of a certain size for a diversified direct real estate investment [Brodin, 2017]. The sizes of the funds which hold long time capital vary. The large AP-funds holds way more capital then the small occupational pension funds, which may have just a fraction of the capital of the large actors. Through investing in larger lot sizes the transaction costs becomes a smaller section of the transaction value as most of the transaction cost is fixed in the majority of transactions [Gavel, 2017].

In order to then gain diversification in the portfolio of real estate, which is important to reduce the risk in the investment, at least five or six properties in different locations should to be included in the portfolio [Gavel, 2017]. The real estate risk is best diversified geographically than through the spectrum of real estate classes [Brodin, 2017]. To create a diversified portfolio of between five and six objects, which would be the smallest number required for a diverse portfolio, you are required an investment of about 2.5 billion SEK. For the real estate investments to correspond to 10% of the total diversified portfolio, this requires the portfolio to hold at least 25 billion SEK worth of assets.
The portfolio asset reach 25 billion SEK the portfolio is, by Swedish comparison, no longer a small portfolio [Svensk försäkring, 2017]. If the fund is unable to own their real estate portfolio directly or through subsidiaries due to size restrictions an option for getting real estate exposure is to invest in real estate funds. These are however, limited in their lifetime and by this more exposed to timing risk as they have a pre-determined end date, and are thereby subject to the market conditions at the end of the lifetime of the fund [Gavel, 2017].

From the statement that the fund is required to have at least 25 billion SEK in assets in order to efficiently invest in direct real estate is not supported by försäkringsbranschens pensionskassa (FPK), they are a fund with about 14 billion SEK in assets and have a portfolio of directly owned real estate. In FPK:s opinion they can manage their current holdings without the concern of size. On the other hand they are currently choosing to invest in real estate through real estate funds [Evander, 2017]. This would support that funds of comparatively smaller size is limited in their real estate investments by the large lot sizes that is bought and sold in the real estate market, but the holding of direct real estate is not subject to the size of the fund.

As mentioned real estate is a real asset and real estate assets are associated with costs that are not present in management of financial securities such as stocks and bonds [Lekander, 2017]. The management cost in real estate includes everything from physical maintenance, reparations and administration. The maintenance is usually outsourced to external partners or handled by a subsidiary. Regardless of how the management of the real estates is manged the total cost of management tend to benefit from economies of scale, meaning that the cost per unit falls as the volume increases [Salen Broman, 2017]. This may be a reason why it is harder for smaller funds to invest in real estate as the task and cost of managing real estate benefit from having a larger portfolio, which however can in part be compensated by outsourcing the management to a larger external partner [Salen Broman, 2017].

4.9.3 Home bias and difficulty finding objects

Swedish commercial real estate objects are heavily owned by Swedish institutions and the institutions mainly have domestic real estate investments [Hellström, 2017]. The reason to invest in the Swedish market is to hedge against inflation and because the liabilities is to be paid in Swedish krona, investments in other countries would cause a currency risk [Salen Broman, 2017]. Another factor is that it is important to know the business partners and that they can be trusted. Investing locally is by some investors considered safer than the benefits that you get from diversification through investing globally [Gavel, 2017]. The problem with the Swedish market is that there are not enough objects for everyone interested in investing in Swedish, low volatility assets to buy. This forces investor wanting to invest in the asset class to take more risky real estate investments [Skogestig, 2017].

A way to limit the risk with investing in more volatile assets would be to diversify amongst real estate assets, both in type and in geographical location. If the investing is carried out over a larger geographical area and to more assets the capital would have to be spread, and the smaller the proportion of ownership to each investment [Hellström, 2017]. The
reduction in ownership and impact in each investment has gotten some investors to reduce their proportion of foreign real estate investments as they wish to decide on how and when to exit the investment and then instead lose some of the diversification benefits that come from with global portfolio [Hellström, 2017].

4.9.4 Regulatory requirements

Institutional investors, such as pension funds have requirements to meet also from the regulatory side. This means that they have to pass the checks from Finansinspektionen (FI), in which the fund needs to be show that they have solvency capital and the risk of each asset class can be managed by the fund [Evander, 2017]. The AP-funds are not subject to these checks but rather restricted in their allocation to real estate in the way that they are not allowed to own real estate properties directly unless for the house they have their office in, they also have to keep at least 30% of the portfolio in interest bearing assets. [Hellström, 2017].

Dependent of the structure of the investment and what risk an investment has also the risk of regulatory changes becomes more apparent [Gavel, 2017]. The regulatory aspects of investments is a risk that has been brought up in most of the interviews. The regulatory risk is a significant factor and it sometimes forces the long time investors to think more in short terms [Evander, 2017]. An example of a current regulatory risk is changes with regards to the stamp duty [Skogestig, 2017], [Hellström, 2017] and [Brodin, 2017]. A change of regulations is a risk that the investors interviewed feels impact the overall risk of the asset class.

Most of the investors that today have an allocation to real estate are institutional investors, such as pension funds with a long time horizon. For these funds capital is locked into the structure and as the system is that those who today save for their pension can not change fund and that way withdraw their savings from the fund. This creates stability as future cash flows are known. A potential risk for institutional investors would be regulations allowing more movement for pension savers. As if unexpected withdraws from the fund would occur the possibility of keeping illiquid investments in the fund might be reduced. Regulatory changes allowing more movement for savers is therefore a risk for institutional investors investing in illiquid assets [Anveden, 2017].
5 Discussion

In this section the results from the interviews and the mathematical modeling is discussed and compared to the literature. The analysis is based on the risk factors of liquidity but also more general characteristics of real estate are discussed together with the concept of institutional investors and their allocation to the asset class.

5.1 Investing in real estate

From the interviews an agreement amongst investors was found that there is an increasing interest in allocating towards real estate and this shift is partly explained by the low interest rates and a desire and/or need to find return from other allocation classes. One way this was described was by Fransson [2017] from AP4 who said that he at a seminar had heard the description “We have lost an asset class” with regards to the low interest levels. With todays levels it is not efficient to have a large allocation to interest related assets. The trend of leaving interest related assets is taking place despite the relatively low volatility associated with this asset class. Future increases in interest levels would mean that current interest related assets would lose in value. For investors this situation could potentially also have a negative impact on real estate returns compared to the returns seen the last few years. The historical returns is presented in table 4.

Real estate has historically averaged a yearly return of 9.2% including all sectors between the years 1987 to 2016 with a volatility of 11.8% or 16.2% de-smoothed with $\alpha = 0.5$. This can be compared to the OMXS30, which has averaged 12.0% return with a volatility of 26.2% during the same time period. This has led to real estate being an attractive investment. For some types of residential real estate the Sharpe ratios has been over one, and for HOX-All Sweden the Sharp ratios has been 0.83. This Sharp ratio is high in comparison to the OMXS30 which during the corresponding period has had a Sharpe ratio of 0.29 since 2005.

The HOX-index has had a noticeable higher Sharpe ratio then the segment of residential real estate presented from IPD data. The HOX represents privately owned real estate and in the IPD are ownership of complexes of rental apartments. Properties in the IPD data are owned by institutional investors. From this it can be concluded that the increase in value of privately owned residential real estate is a segment which the institutional investors can not attain. Privately owned real estate have the last years had a high return but it also needs to be noted that the HOX data is data from the period 2005-2016. This is a period where real estate has had a stable development and which was moderately impacted during 2008 in Sweden. The IPD data on the other hand also reflect the real estate crisis seen in Sweden 1990 [Englund, 1999].

It should also be noted that residential real estate is the sector which has had the most stable growth and have outperformed the other segments of real estate historically [IPD, 2013]. The outstanding performance have brought up the question of how representative the measured volatility is [Kaplan, 2012]. If the efficient market hypothesis is correct then there has to be some risks or rewards not visible in the data if the Sharpe ratio differ between assets and it is possible to get higher return without increasing risk through selecting other investment alternatives. The same has been seen from IPD, as
seen in figure 7, residential real estate has outperformed the other real estate sectors since 1987.

5.1.1 Volatility

Amongst the investors interviewed, a large reason for investing in real estate seem to be the quite low volatility combined with good return that real estate has shown historically. A stable price development is a desired trait to have in an asset portfolio [Brodin, 2017], [Salen Broman, 2017]. The volatility has, as can be seen in table 12 varied between 5 - 8% adjusted for the ex-ante variance since 2005 for HOX residential indexes. This is low compared to stocks which in Sweden have had a standard deviation of about 17% during the same time period and OMXS30 has yielded about the same return as residential real estate.

In the case of smoothed IPD-data, i.e. not adjusted for the auto-correlation, the volatility is higher for the scaled volatility and it varies between 8 and 13% between 1987 and 2016. This may in part be because of the difference between the underlying in IPD an HOX, that IPD is an annual index and HOX a monthly index. Also the indexes covers different time periods. If de-smoothed data is used the volatility becomes even higher, then the scaled variance is between 16 and 21%, which is expected as the process of de-smoothing is designed to bring back volatility to the index.

The empirical findings also revealed that most investors do not use volatility when estimating the risk in direct real estate investments but rather assume a volatility from intuition or that of traded real estate firms. This will further be discussed under the section of valuation risk (section:5.3.2). If the true volatility of direct real estate coincide with that of traded real estate stocks, which would be a consequence of using the volatility of traded real estate stocks as a basis for volatility of direct real estate investments, then real estate would not be a low volatility asset.

The low volatility which can be measured in the real estate indexes should be handled with caution, as there is a general understanding amongst literature that real estate indexes tend to underestimate the volatility in real estate [Geltner, 1992], [Edelstein & Quan, 2006], particularly in valuation based indexes such as IPD. As HOX is a transaction based index the underestimation of the volatility can be assumed to be slightly lower than it would have been in for example IPD. Despite this it needs to be noted that HOX is only reported on monthly basis and the volatility of the index will be reduced by the lack of measuring points. A common way to deal with the smoothing of valuation based indexes is to use de-smoothing, as presented in section 3.6.5.

5.1.2 De-smoothing of data

The de-smoothing is an accepted and used method to compensate for the previously described issues of smoothed indexes. The process of de-smoothing have a critical moment of choosing the de-smoothing parameter ($\alpha$). In this study $\alpha = 0.5$, but also other values in the range suggested by Geltner [1992] were tested to see the effects on the IPD-data. Geltner [1992] suggests the interval of $1/2 - 2/3$ as the range which give the best estimates for the volatility post smoothing. The smaller factor the larger the increase in volatility. The scaling factor $\alpha$ is in reality dependent on time and the type
of property [Geltner, 1992].

When the de-smoothing with $\alpha = 0.5$ was conducted the volatility in the IPD index increased with about 40%, which is a notable increase. Despite the large increase in standard deviation from the de-smoothing process the residential real estate investments have historically given high risk adjusted returns compared to stocks and bonds. All other IPD sectors does after de-smoothing with parameter $\alpha = 0.5$ show risk adjusted returns on par with OMXS30 and 10 year Swedish government bonds. Under the efficient market hypothesis that the Sharpe ratio is at the same scale, it should be an indicator that after adjusting for smoothing of the data, i.e. the valuation risk and transaction period risk through the ex-ante variance the risk with investing in real estate should be accounted for.

5.1.3 Correlation and real estate risk factors

Another reason why some of the participants in the interviews held a section of their assets in real estate, as found in section 4.4, is motivated by the different risk exposure compared to that of stocks and bonds. Real estate assets are not only impacted by liquidity and interest levels but there are several other factors which increase the risk associated with real estate. These risks are diverse and include for example the risk of mold in a property, fire and other direct risks which can be insured against through traditional insurance schemes [Brodin, 2017]. Another risk that affects real estate is the market risk, presented in section 4.5. In a falling market or recession, real estate values are impacted both as the occupancy levels fall as well as the demand for real estate decreases. This brings the values of properties down. The market risk is present for most investments and also for real estate, the results showed interesting patterns when examining the correlation in different stages of the market cycle.

The difference in risk factor exposure can be seen in the correlation between stocks and real estate in figure 10. The rolling correlation between the assets have ranged between -0.8 and 0.6, but has mostly been positive and low. Having negative correlations is desired as this can work as a hedge and reduce the overall volatility of a portfolio [Berk & DeMarzo, 2014]. In the figure 10 it is worth noticing that the correlation has increased during times of market turmoil such as during the financial crisis. This is a fairly poor trait to have in a portfolio as the need for good diversification between assets is most needed during times of crisis, when stocks are expected to decrease in value. At the same time it is clear that the correlation between real estate and treasury bills has the most beneficial relationship during the same crisis, which is expected as the demand for the safe assets increase during times of crisis, whereas the demand for risky assets fall during a crisis [Anveden, 2017], giving treasury bills and real estate a very beneficial correlation pattern.

5.1.4 Portfolio weighting and re-balancing

When using for example portfolio optimization models as for example the AOM model to create an efficient portfolio the correlation between assets is important [Berk & DeMarzo, 2014]. A diversified portfolio can be created through including assets with low correlation, and this way lowering the portfolio risk for the same expected return. A problem when doing for example portfolio optimization is that a period to
calculate correlation over has to be selected. In the case of investing in real estate the correlation has varied a lot over time and tend to be higher during times of crises. Depending on the selected time period for correlation investors are using for the the optimization the obtained optimal level of real estate would vary, this may lead to the consequence that the fund get a suggested over allocation to real estate from the optimization algorithm.

Another factor which plays an important role in effective portfolio management is the possibility of re-balancing the portfolio. To always have an optimal portfolio there must be the possibility of trading to adapt the portfolio depending on the current market conditions [Cornelius et al., 2013]. For real estate investments this becomes a problem as they take time to trade as can be linked to its lower degree of liquidity. Consideration with direct real estate investments are that they have higher transaction costs than standardized assets and the process of trading takes longer time. These factors make real estate a more long time investment which makes the portfolio harder and more expensive to re-balance.

The historical performance of real estate and the fact that investors mostly are under-allocated in the asset class [Hoesli et al., 2003] decreases the impact of re-balancing. In literature Hoesli et al. [2003] find the optimal real estate allocation to range between 15-25%. Lekander [2016] finds the optimal allocation to direct real estate on the Swedish market to be 14%. Many Swedish institutional investors today have between 5-10% of their portfolio in the asset [Brodin, 2017]. For smaller proportions of real estate in a portfolio the liquidity risk is limited, but for larger allocations the characteristics of liquidity gains importance.

5.2 Liquidity in real estate

As real estate is an assets which usually takes time to convert to cash with a longer transaction process with fewer potential buyers the degree of liquidity in the asset class is low [Anson et al., 2011]. In literature, it is stated that the compensation for liquidity risk that real estate bring to a portfolio should be compensated for by a liquidity premium [Ang, 2014]. From the interviews it became clear that the views with regards to liquidity premium vary. Even thought most interview participants claim that such a premium exist and that this is a major reason for investing in real estate, no quantitative estimates could be given by the interview participants regarding the size of the premium. The lack of size estimates indicates the difficulty in trying to find a quantitative estimate for the liquidity premium.

The difficulty in defining the liquidity premium for alternative investments lay in several factors that can be summarized by the differences in definition, how it should be calculated and the lack of data available for alternative investments. As the definition for liquidity differs it also becomes a problem of what should be considered liquidity and what measurements should be used in calculating the premium. Part of the problem from the difference in if the liquidity premium should be calculated as a premium over the risk premium or if the whole risk premium should be seen as an liquidity premium since it is of an illiquid investment. Also if data have been de-smoothed or not is important for the matter. In the interviews the degree of liquidity was found to differ between objects and
the investors even talked about 'liquid- and illiquid real estate'.

5.2.1 Real estate characteristics

Real estate have different characteristics and every property is unique. This makes the assets have different degrees of liquidity [Brodin, 2017]. Salen Broman [2017] (4.3.1) referred to the CAIA Associations [2016] attribute as Core, Value-adding or Opportunistic together with the location of the property to affect the liquidity risk. The different types of real estate can serve different purposes in a portfolio and have different characteristics affecting the potential return and also the degree of risk in the portfolio. From this it could be argued that within real estate there is a scale of liquidity, where Core objects are being the more liquid assets and Opportunistic real estate the least liquid.

Based on the framework of real estate characteristics developed by the CAIA Association [2016] presented under section 3.4.3. The eight characteristics affecting a single property are; type, life-cycle phase, occupancy, roll over concentration, near term roll over, leverage, recognition and investment structure. From the interviews it was found that type and life-phase were two important characteristics for the investors as some only invested in newly built properties and others only in different types or as defined by IPD [2016] segments. The most important characteristic seemed to be the occupancy level. If a property loses its tenants the yield decreases and the value of the property will decrease, this will also make the property harder to sell [Salen Broman, 2017]. The risk of occupancy is also associated to the Liquidity risk of income seen in Hordijk and Teubens [2008] model and discussed under section 5.3.1.

5.3 Risk factor exposure

From the literature review (3.6) the factors affecting liquidity of a single property was the more general perspectives from Hordijk and Teuben [2008]. These factors are; liquidity risk of income, valuation risk, heterogeneity risk, opportunity risk and transaction risk. In the following sections these will be discussed further. From the interviews it was found that the different factors have varying impact on the overall risk associated with the illiquidity for real estate assets. Amongst the investors the liquidity risk of incomes and transaction risk were considered the largest liquidity risk factors for single properties. For a portfolio of real estate assets, these risks could be differentiated to become lower and the valuation risk then became the most essential.

Each of the liquidity risk factors will here be discussed individually from a perspective of the contribution to the overall risk with illiquid investments.

5.3.1 Liquidity risk of income

The liquidity risk of income is the risk of being stuck in an investment which generates low or no return [Hordijk & Teuben, 2008]. The risk is usually linked to vacancies or tenants not being able to pay rent. The risk of not getting any return from an investment is always present but from the interviews (4.4.2) this risk is mitigated through investing in areas with high demand and buying properties with long leases. This risk can also be reduced by having many different tenants to rent to rather than to be dependent on one counterpart. If new projects are started a way to mitigate the risk is to build for a
customer rather than to build on speculation [Salen Broman, 2017], this is possible in office spaces and other commercial properties but harder in new residential real estate projects [Gavel, 2017].

The liquidity risk of incomes is present in real estate investments but there are ways to reduce this risk. If steps are taken to limit the overall risk from the liquidity risk of income factor the remaining risk becomes the market risk. The risk of vacancies will further be discussed as such and any decrease in value and risk from vacancies will be measurable in the assets volatility.

5.3.2 Valuation risk

As pointed out by Angberg [2017], the valuation risk in real estate is hard to determine as it depends on if a single assets or a portfolio of assets should be valuated. The valuation of singular property is quite straight forward compared to for example valuation of a private firm [Gavel, 2017]. The problem with valuation of real estate assets arise when valuing a portfolio of real estate [Fransson, 2017].

The smoothing of indexes and its difficulty in representativeness for all properties arise from real estate assets being traded infrequently which makes it hard to construct reliable indexes from transactions. The two main types of indexes available are either valuation based indexes or regression based indexes [Valueguard, 2011], [MSCI, 2016]. Both index types have their pros and cons. The issue does however remain with either index type that it is hard to use traditional statistical techniques for valuing a portfolio of real estate. Based on the real estate characteristics as described in section 3.4.3 and the interviews it is found that the fact that each property is unique add to the valuation risk in real estate through increasing the uncertainty with regards to the risk and return profile as the index is not representative for the portfolio.

On the other hand real estate in singular is simple to value; making the problem with valuation more of a trade-off between which valuation technique to use. Either being to general and use the entire market or to granular and value each property [Angberg, 2017]. Despite this, the valuation risk is something that needs to be considered and which is not included in the ex-ante volatility or the market volatility and which makes the de-smoothing process to gain importance.

5.3.3 Heterogeneity risk

Heterogeneity risk with regards to liquidity is the risk that arise from objects not being comparable and the uniqueness with each investment [Hordijk & Teuben, 2008]. From the interviews it was found that this risk is not considered as a large problem, if even a problem at all. Investors were aware that properties differ and that these could not be comparable, but they saw no risk of liquidity for this reason. From this it could be assumed that the risk associated with heterogeneity of real estate is a small risk factor and that will not have a large impact on the overall liquidity risk from real estate.
5.3.4 Opportunity risk

Opportunity risk is the risk of not being able to take on better investment opportunities if these would arise. The opportunity risk associated with real estate as opposed to stocks or bonds is that when investing in real estate the investment horizon and transaction period are longer, making the time it takes to change allocation longer [Hordijk & Teuben, 2008]. This risk has, based on the findings from the interviews been regarded as a limited risk. This is as the pension funds included in the study only have a small section of their holdings in illiquid assets and can therefore move into investment opportunities by taking capital from more liquid asset classes. From the interviews it can be concluded that the pension funds would only consider the opportunity risk as a considerable risk factor if the section of illiquid assets was a substantial part of the portfolio.

5.3.5 Transaction process risk

The transaction process risk is the risk of not knowing how long time it will take to sell an asset at market price [Hordijk & Teuben, 2008]. This risk is low during good market conditions when the demand for assets is high [Salen Broman, 2017], [Skogestig, 2017]. There seemed to be an agreement amongst those included in the interviews that expected sales period under neutral or positive market conditions is between three and six months (seen in table 5). On the other hand, the time it will take to sell a real estate asset during negative market conditions seemed more uncertain, and some even said that some properties are unsellable under negative market conditions, in particularly properties in areas where there are only one natural buyer which is typically the case in rural areas or smaller cities.

The risk of not being able to sell a property [Amihud & Mendelson, 1986], or with an unknown transaction time [Anson et al., 2011] or with a price reduction [Damodaran, 2005] makes the transaction process risk a large risk factor which needs to be considered when deciding to invest in an illiquid asset. The risk of not being able to sell an asset can be assumed to be reason for why it tends to be more beneficial to invest in direct real estate or real estate companies than closed fund structures. Open structures gives the investor a greater power to decide on the selling time, in comparison to the fund structures which has a pre-determined life time after which the fund manager is forced to sell regardless of the market conditions. Combining the importance of the transaction process described in literature with the findings from the empirical study, it can be concluded that the transaction process risk is a substantial risk factor which enhances the applicability of the ex-ante variance as it is designed to measure the transaction process risk.

5.4 Ex-ante variance

As mentioned in section 5.3.5 the transaction process risk is considered to be a large risk factor with regards to the overall liquidity risk. A way to estimate the transaction process risk is through ex-ante variance scaling. The variance scaling in the ex-ante model includes data on return, standard deviation, expected holding period and transaction time [Bond & Huang, 2004]. From the modeling it became apparent that the transaction period compared to the holding period is an important factor for the overall transaction process risk. From the interviews most of the respondents mentioned that they did not have a near time horizon for their investments and that their real estate holdings were
not expected to be sold soon.

The transaction period could be estimated to be between three and six months based on the answers of the investors. This transaction time also correspond of the findings of Hordijk and Teuben [2008] who find that most transactions takes between two and six months. As pointed out by Cameras [2017] these transaction times only include successful transactions and some objects are removed from the market as the assets never sell. For these institutional actors the transaction risk scaled by the ex-ante variance is limited as these do not have an end date for their investments. On the other hand the transaction risk becomes more visible to fund structures with a near time end date.

One consideration when calculating ex-ante variance from historical data is that the transaction period used in the formula is assumed to be exponentially distributed. From the data available this assumption could not be tested. If this assumption does not hold on the Swedish market the findings from the model could potentially be misleading. Another limitation with ex-ante variance is that it is only designed to account for the transaction period risk and not other risk associated with illiquidity.

When the scaled variance for HOX-index and residential real estate was calculated it was found that, even with the higher risk factors the risk adjusted return is significantly higher than that of stocks and bonds. This could for example be caused by other liquidity risk factors than the transaction period risk which was scaled for with the ex-ante variance, or the valuation risk which is what de-smoothing process should account for. The high risk adjusted return could also be related to the high management or transaction costs which are not visible in the available data. Unfortunately, a problem with risk factors in real estate is that it is hard to measure as well as that it is hard to quantify how to distribute the risk between different factors. Therefore, from the historical return data it can only be concluded that residential real estate has had a higher risk adjusted return than stocks and bonds. It can also from IPD-data be seen that other types of real estate have historically had a lower risk adjusted return compared to residential real estate.

5.4.1 Transaction process risk premium

The risk with having an unknown transaction period can, as mentioned previously be quantified through the ex-ante variance scaling. Under the assumption that increased expected return comes at the cost of increased risk. The risk calculated as transaction process risk premium was found to be comparably low, as seen from table 13 and table 14. This indicates that out of the overall risk with investing in illiquid assets in terms of real estate the transaction process risk associated with unknown transaction process makes up a small proportion of the total risk. The transaction process risk will therefore result in a small premium. On the other hand, from the interviews it was found that the transaction process risk is together with valuation risk and liquidity risk of income considered as the most important liquidity risk factors for real estate investments. This is a case where the quantitative and qualitative findings do not match.

The reason for the mismatch might be that during interviews, when the participants estimated the transaction period their estimate it was based on the last couple of years, which have been a period of high demand for real estate, and thereby comparatively
short transaction periods. At the same time the interview participants are aware that there is a risk that the demand for the assets fall, leading to longer transaction periods and greater risk. This imbalance between historical estimates and fear of decrease in demand may be some of the explanation behind the mismatch behind our quantitative and qualitative findings with regards to the transaction process premium. Another factor that may contribute to this mismatch is that investors have over the last couple of years increased the holding period for their real estate holdings as seen in table 6. The increase in holding period will deduct from the transaction process risk. In the interviews the participants may not consider the factor that the transaction process as a factor of the holding period is falling further contribution to the mismatch between the qualitative and quantitative findings. The mismatch may also be the result of errors in calculations or errors in the interview method. All in all the quantitatively findings shows on a low level of transaction process risk and the qualitative findings points at transaction process risk being an important factor but the reason for this difference could not be determined under the scope of this study.

5.5 LIQUIDITY AND MARKET CYCLE

The liquidity in the market is strongly dependent on the market cycle. During times of crisis the liquidity tend to fall as the values fall [Salen Broman, 2017], [Ang, 2014]. How large this risk actually is, is hard to estimate since Swedish institutional investors could wait out the financial crisis which occurred around 2008, as they had strong balance sheets and long leases with their tenants [Bergström & Hansen Vikström, 2017], [Skogestig, 2017]. The number of transactions decrease during recessions [Skogestig, 2017], [Salen Broman, 2017] and in the literature presented from amongst others Geltner [1992] the bias of smoothed indexes therefore tend to not show the actual volatility. The consequences of falling market cycles have been limited in Sweden the last years as the times of negative markets have been limited in time and most investors have been able to wait them out [Bergström & Hansen Vikström, 2017], [Skogestig, 2017].

Liquidity is also connected to the supply and demand and during good markets with many buyers the supply to demand is low and this decreases liquidity in comparison to bad times. For Core objects with many potential buyers the liquidity risk is lower in comparisons to areas with less potential buyers [Salen Broman, 2017], [Fransson, 2017]. Alternative real estate from the category of Opportunistic tend to gain lower liquidity periods of falling markets compared to other real estate assets [Salen Broman, 2017].

Another aspect that also is interesting with regards to market cycles and liquidity is that if liquidity is defined as suggested by Damodaran [2005]; as an asset that can always be sold and it is rather of question of what price the seller is willing to accept. If the price which an investor is willing to accept is dependent on the price which the investor bought the asset for the market cycle plays an important role for liquidity. If the market would go down and an asset was bought at a high price this would then according to Damodorans [2005] definition imply liquidity risk for the seller. The market risk is also present for other asset classes but dependent on how liquidity is defined it could also impact the market risk.
5.5.1 Forced sale

As seen in the results of section 4.8 the effects of forced sale could, depending on the market cycle, also have an impact on the expected return. The risk of forced sales was considered a limited risk for the institutional investors interviewed. This was mainly as the investments were made with a long investment horizon and only a small section of the capital is invested in real estate. Despite the low probability of having forced sales the potential effect of ending up in a situation not selling through the traditional channels with limited time for the transaction process can have great price impact. The liquidation premium in 4.8.1 showed numbers of 10.3% for IPD and 4.6% for HOX for a six months transaction period. In the retail residential market i.e. real estate sold in lot sizes for an individual real estate the estimated fall in value was between 20 and 30% of estimated market value based on studies conducted on historical forced sales [Donner et al., 2016].

The drop is depending on the reason behind the sale and the reduction in transaction process time. A problem with these studies is that it is hard to estimate the condition of the properties sold, and the authors bring up this as a potential bias in that study. [Donner et al., 2016]

5.6 Managing liquidity

From the interviews it was also found that the risk for the overall portfolio with regards to liquidity is strongly dependent on both the section of the portfolio allocated to illiquid assets and the overall strength of the funds balance sheet. For the institutional investors in Sweden the effects of liquidity risk seemed to be limited as the investors have both strong balance sheets as well as a limited section of their portfolio in illiquid assets. This study is limited to investors with a long investment horizon and this was found to likely have a impact for the liquidity risk. The limited fear of liquidity risk the institutional investors saw in real estate was partly explained by the awareness that real estate investments are illiquid. It can take time to sell the illiquid assets and almost be impossible to sell during turbulent market conditions [Cameras, 2017], [Skogestig, 2017], [Gavel, 2017]. Liquidity risk is largest when it occurs on unexpected places and when assets that were thought to be liquid proves to not be, as when Lehman when bankrupt 2007 [Brodin, 2017].

Many institutional investors in Sweden have a high solvency level which makes it possible to make investments in less liquid assets [Fransson, 2017], [Evander, 2017], but there are exceptions. In year 2009, after the financial crisis, one fairly large Swedish pension fund was forced to sell of assets as they did not meet the solvency requirements [Fransson, 2017], [Salen Broman, 2017]. So even if most Swedish institutional investors have high solvency there has been examples in which funds have been forced to sell in order to compensate for their solvency. The proportion of alternative and illiquid investments in the portfolios of institutional investors today is in many cases lower than the suggested share of 15% [Brodin, 2017] obtained by portfolio optimization through AOM framework [Lekander, 2016]. The high solvency and relative small share of real estate investments by most actors led to the conclusion that the risk for liquidity is a limited fear amongst Swedish institutional investors under current conditions.
5.6.1 Risk appetite

Based on the Risk Appetite Framework (RAF) [Girling, 2013] it was found that Swedish pension funds risk appetite is controlled by a high risk capacity but with limited degrees of risk tolerance. The high risk capacity comes from the large amounts of capital pension funds hold, low degree of immediate liquidity needs and a structure of liabilities with a long time horizon [Hellström, 2017]. The risk tolerance is limited by the need to actually pay future liabilities and pension savings cannot be at risk of getting lost. Pension funds have future requirements on what needs to be paid but also requirements on what yield the assets need to achieve to meet their longterm obligations [Evander, 2017].

The liquidity risk arise from the imbalances between assets and liabilities [Carrel, 2010] and therefore it can be assumed that for pension funds that have liabilities with a long time horizon illiquid investments can be made. Matching the duration of assets with liabilities is the best way to hedge liquidity risk, but this is in reality a complicated process as the assets are volatile. The reasons for the liquidity risk vary and can be driven by external factors such as; counter party risk or regulatory risk [Carrel, 2010]. Amongst the investors interviewed the liquidity risk of future liabilities is today controlled as these can be monitored and discounted to todays value using the interest rate as discounting factor [Salen Broman, 2017]. To protect a fund against liquidity risk, monitoring and a constant follow up on risk are steps that can be taken in order to limit the effects of these [Carrel, 2010]. Many of the interviewed funds does some kind of stress testing to make sure that they can manage different market scenarios. A potential risk with illiquid investments would be regulatory changes in the system allowing pension savers to withdraw capital or change their savings to another fund at a point earlier than expected.
6 CONCLUSION

In this section the study is concluded by answering these research questions. This is conducted from the subjects of real estate risk factors, liquidity from real estate and how this affects the portfolio perspective.

6.1 REAL ESTATE RISK FACTORS

The first research question was to answer: What risk factors does real estate contribute to a portfolio? Our results show that the main risk factors that real estate contribute to a portfolio are: market risk, object specific risks and liquidity risk.

Market risk is a risk factor impacting most asset classes, and is also a risk impacting real estate. The market risk is traditionally measured using the volatility of the asset class, and the larger the volatility the larger the exposure to the market risk. In the case of real estate the volatility is artificially low, caused by the natural smoothing from valuations as well as the low frequency of reporting. The issue with smoothing can be managed through the de-smoothing process which is dependent on a smoothing parameter. If the de-smoothing process is not conducted IPD - All property has a volatility of 11.8% which is low compared to stocks which over the same period (1987-2016) had a volatility of 26.3%. If the IPD - All Sweden is de-smoothed with parameter \( \alpha = 0.5 \) the volatility increase to 16.2% per year. The market risk can also contribute to correlation between asset classes. For example is the correlation between real estate and stocks strongly dependent on the market conditions as they are both exposed to the same market risk, and thereby tend to drop in value at the same time as seen in figure 10. To have assets which increase in correlation during times of crisis is undesirable as the correlation is most needed during these times.

The object specific risks are, as the term entail, dependent on the the characteristics of the individual object. The characteristics can be divided into eight factors as suggested by CAIA Association [2016] in section 3.4.3, but also dependent on the location of the object. The real estate characteristics can be classified into three sectors; Core, Value-added and Opportunistic, here named in the order of risk increase. The location contribute to the objects risk as the liquidity risk decreases as the location becomes more central [Salen Broman, 2017].

The third risk factor from real estate is the liquidity risk. The liquidity can be defined in different ways and how it will impact the portfolio is dependent on the definition, but in general the level of liquidity is dependent on the time it takes to sell an asset at market price. The faster an asset can be sold at market price, the more liquid. The liquidity risk can be divided into five main factors for real estate objects [Hordijk & Teuben, 2008]. Not all factors are of the same importance to the overall risk. From the interviews it was found that transaction process risk is considered the most important liquidity risk factor followed by, equally important, valuation risk and liquidity risk of income.

6.2 LIQUIDITY RISK FROM REAL ESTATE

How much of the total real estate risk can be explained by illiquidity and how can illiquidity risk be calculated?
The liquidity risk can, as mentioned, be divided into five parts. As found from the interviews, the transaction process risk, valuation risk, and liquidity risk of income are considered the main risk factors. The transaction process risk can be measured using the ex-ante variance model [Bond & Huang, 2004]. The transaction process risk was found to be low. The variance scaling of IPD - All property, prior to de-smoothing, resulted in a scaling factor of 1.013 which, in turn, gave a transaction process premium of 0.043% per year. When de-smoothed IPD - All property was used, the variance scaling factor was found to be even lower at 1.006, which gave a transaction process premium of 0.015% per year. With regards to the valuation risk, the de-smoothing process is designed to compensate for the risk associated with the inherent smoothing of valuation-based indexes. The process of de-smoothing generated a large increase in the volatility. The liquidity risk of income on the other hand can be seen in the index as lower income decrease the asset value.

In addition to the liquidity risk factors, the compensation for a potential fire sale was calculated. For HOX-All Sweden an additional 0.95% annual return was needed to compensate for the risk of forced sale given a ten year lock in period and two percent probability of forced sale. The liquidation premium in the observed return bias for a forced sell of HOX - All Sweden property was found to be 4.8%, for an immediate sale and a six months estimated transaction period. This can be compared to the market return of 7.3% per year if there is desired time to sell the asset. Calculations on the potential risk of immediacy in the sales process were quantitatively found to have an impact if the investor had a risk of ending up in the situation. Amongst the institutional investors this risk was seen as fairly low as all interviewed had strong financial positions and long investment horizons and therefore saw a low probability of ending up in a position where forced to sell.

6.3 Real Estate and Illiquidity from a Portfolio Perspective

Finally, the last and more overarching research question posed in the introduction is: What aspects in the overall portfolio affect institutional investors’ ability to invest in illiquid assets?

From a general portfolio perspective, some factors were found to be more important for the investors’ ability to make real estate investments. As real estate takes time to sell as seen in table 5 and is affected by liquidity as previously discussed, this created demands of having a stable portfolio, if illiquid investments should be made without causing too much risk. From the interviews, it was found that the total portfolio mix affected the ability of making illiquid investments and the risk of liquidity gains importance as the share of illiquid investments in the total portfolio increases. With a small proportion of illiquid assets in the overall portfolio, the risk is limited [Brodin, 2017]. Not only the portfolio mix but also the total solvency affected the investors’ ability to make real estate investments. With a high degree of solvency and other assets of value, illiquid real estate investments can be made [Cameras, 2017].

To minimize the potential consequences of the liquidity risk in the portfolio, the approach suggested by Carrel [2010] is to measure the risk, work with asset liability management, and to track risk concentrations. Most interview participants did some kind of stress testing of their portfolios to see how it would perform for different scenarios. The
investors were also aware that the real estate segment was a part of the portfolio that might not be able to sell during falling markets. The common understanding amongst the interviewees was that in a situation of a need for cash in a falling market other assets would be sold before the real estate assets.

The Swedish institutional investors have historically been able to wait out recessions and rather seen the possibility to expand their real estate segment than selling of assets during these periods [Hellström, 2017], [Gavel, 2017]. Institutional investors; for example pension funds have a long time horizon which seen in Carrels [2010] model as ALM, makes it possible to make long-time investments. The fear of being locked in seemed to be limited by the investors interviewed. The long investment horizon is sometimes disrupted by rules and regulations and this is an external risk which have a strong impact on investors [Skogestig, 2017] and force them to sometimes think less long term and make decisions that are not financially optimal [Evander, 2017]. A major regulatory risk that potentially could affect institutional investors possibility of making illiquid investment would be if more movement was allowed for pension savers and capital in funds would be withdrawn at a point earlier than expected [Anveden, 2017].
REFERENCES


[CEBS, 2008] CEBS - Committee of European Banking Supervisors. (2008). CEBS’s technical advice on liquidity risk management (second part) - Analysis of specific issues listed by the Commission and challenges not currently addressed in the EEA.


INTERVIEWS


Appendix

Appendix 1

Continued derivations of liquidation premium

We had that

\[ \mu_{T+h+\lambda} = \frac{P_T}{P_0} \]  \hspace{1cm} (16)
\[ \mu_{M+h+\lambda} = \frac{P_M}{P_0} \]  \hspace{1cm} (17)

from the uniform distribution where \( P_T \in [p^*, p^u] \) and \( P_M \in [p^l, p^u] \);

\[ \mu^M = \mathbb{E} \left[ \frac{P}{P_0} \right] = \frac{\left( p^l + p^u \right)}{2P_0} \]  \hspace{1cm} (18)
\[ \mu^T = \mathbb{E} \left[ \frac{P_T}{P_0} \big| P_T \geq p^* \right] = \frac{\left( p^* + p^u \right)}{2P_0} \]  \hspace{1cm} (19)

\[ \sigma^2_M = \text{Var} \left[ \frac{P}{P_0} \right] = \frac{\left( p^l + p^u \right)^2}{12P_0^2} \]  \hspace{1cm} (20)
\[ \sigma^2_T = \text{Var} \left[ \frac{P_T}{P_0} \big| P_T \geq p^* \right] = \frac{\left( p^* + p^u \right)^2}{12P_0^2} \]  \hspace{1cm} (21)

\[ E[T] = \frac{p^* - p^l}{p^u - p^*} \]  \hspace{1cm} (22)

\[ \frac{p^u + p^l}{2P_0} = \frac{p^u + p^*}{2P_0} - \sqrt{3} \frac{p^* - p^l}{p^u - p^*} \sqrt{\frac{(p^u - p^*)^2}{12P_0^2}} \]  \hspace{1cm} (23)

For full explanation of this see Lin and Vandell [2007] this however gives the measures;

\[ \mu_T - \mu_M = \sqrt{3} E[T] \sigma_T \]  \hspace{1cm} (24)
\[ \sigma_M - \sigma_T = E[T] \sigma_M. \]  \hspace{1cm} (25)
**Appendix 2**

**Interview questions Pension funds**

Hur tänker ni kring alternativa investeringar?
- Med avseende på tidshorisont, avkastning och risker?

Hur har den historiska trenden varit att inkludera olika tillgängsslag?

Hur stor del av er portfölj vill ni ha i fastigheter? / har ni?

Hur ser ni på investeringar i fastigheter?
- Med avseende på tidshorisont, transactionstid, avkastning och risker?

Hur tänker ni i era allokeringar?
Hur mycket i respektive tillgängsklass?
Vad styr detta?

Hur tar ni fram investeringsbeslut?
Vilka modeller använder ni för att ta fram detta?

Hur matchar ni era framtida utbetalningar?

Hur ser ni på illikviditet, påverkar detta era investeringar?

Hur bestämmer ni er risknivå?

Vilka är huvudsakliga riskerna med fastigheter?

Vilken avkastning förväntar ni er från fastigheter på lång sikt?
Från värdeökning respektive från loppande betalningar?

Vilken volatilitet räknar ni med att fastigheter har på lång sikt?

Hur lång tid tar det i genomsnitt att sälja fastigheter (eller de för fastighetsbolag ni äger)? Per sector (Retail, office, residential, ware house)

Hur lång tid äger ni i genomsnitt en fastighet (eller de fastighetsbolag ni äger)? Per sector (Retail, office, residential, ware house)

Hur har trenderna inom fastighetsinvesteringar sett ut på senaste tiden?
Varför tror du att denna trend blivit?

Hur ser du på illikviditetsrisken i fastigheter?

Hur stor andel av er portfölj kan ni ha i illikvida tillgängar?

Hur tänker ni kring illikvida tillgängar?

Hur går ett investeringsbeslut till?

Hur stor del av en pensionsportfölj tycker du ska vara fastigheter? Varför?

Hur tror ni det skiljer mellan olika typer av investerare?
Tror du att det finns risk för bubbel tendenser/krasch i Svenska fastighetsmarknaden? Har du varit med om någon sådan? Hur upplevde du detta?

Vilka är de största utmaningarna för pensionsbolag idag?

Hur skiljer sig investeringar i de olika kategorierna? (Retail, office, residential, ware house) Har du märkt någon förändring hos investeringar från institutionella investerare?

Vad är fördelarna med att hyra fastigheter? Vad är fördelen med att köpa fastigheter?

Har ni varit med om perioder där ni tvangats sälja av tillgångar?

Vad säljer ni först när ni behöver cash?

Hur går ni tillväga för att göra allokeringsbeslut?

Hur ser du på dessa risker? Vilken störst?
  - Transaction process risk
  - Liquidity risk for incomes
  - Opportunity risk
  - Accurate valuation risk
  - Heterogeneity risk
APPENDIX 3

INTERVIEW QUESTIONS Real estate companies

Varför ska man investera i fastigheter?

Hur tänker ni när ni gör en investeringar?
Vilka parametrar är viktiga?

Vilken avkastning förväntar ni er från fastigheter på lång sikt?
Vilken risk?

Vad har ni för avkastningskrav?

Vilken volatilitet räknar ni med att fastigheter ger på lång sikt?

Hur lång tid tar det i genomsnitt att sälja fastigheter?
Per sector Retail, office, residential, ware house

Hur lång tid äger ni i genomsnitt en fastighet?
Per sector Retail, office, residential, ware house

Hur har trenderna inom fastighetsinvesteringar sett ut på senaste tiden?
Varför tror du att denna trend blivit?

Vilka är huvudsakliga riskerna med fastigheter?
Hur ser du på illikviditetsrisken i fastigheter?

Tror du att det finns risk för bubbel tendenser/krasch i Svenska fastighetsmarknaden?
Har du varit med om någon fastighetskris?

Hur skiljer sig investeringar i de olika sectorerna?
Har du märkt någon förändring hos investeringar från institutionella investerare?
Hur märks de institutionella investerarna i er bransch?

Vad är fördelarna med att hyra fastigheter?
Vad är fördelen med att köpa fastigheter?

Hur ser du på dessa risker? Vilken störst?
- Transaction process risk
- Liquidity risk for incomes
- Opportunity risk
- Accurate valuation risk
- Heterogeneity risk