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Why Include Real Estate and Especially REITs in Multi-Asset Portfolios?

Authors:

Elias Wiklund
101871

Joachim Hansen Flood
102530

Supervisor:

Jens Lunde

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Abstract

This thesis has explored the characteristics of real estate as a financial asset in regards to portfolio building, with a particular focus on REITs. This was done to clarify if real estate should be included in large-cap investors' portfolios, and when that is the case, what allocation.

Extensive qualitative analysis has been performed, mainly examining existing research in both the field of real estate and portfolio theory. The financial implications of investing in REITs versus buying properties the traditional way (direct) has been explored, as has the macroeconomic implications for different real estate segments.

The asset allocations of the most prominent large-cap investors have been assessed. Not surprisingly, all the largest asset managers have allocated some funds to real estate. An unexpected finding was how dissimilar the asset managers' portfolios were, despite having the same goal of growing the capital they are managing for investors. The disagreement within the asset management industry indicates that further research on the field has relevance.

Quantitative analyses of the U.S. public stock- and bond markets have been conducted, where returns, volatility, and correlations were examined. Based on this, historical tangency portfolios were found, demonstrating what weight of real estate in combination with other asset classes has yielded the best risk-adjusted returns in the past. The analysis used data from 1994 until 2020, making it evident that over different historical periods, different allocations to REITs, stocks, and bonds were optimal. However, the spread was not too substantial: Using data from the last 20-years, a 14% allocation to REITs generated the maximum risk-adjusted return, while considering the last five years the optimal allocation to REITs was 15%.

The thesis has investigated the effects of the ongoing COVID-19 pandemic. Industry segments relying on non-essential traveling, especially hotels and shopping malls, have been critically struck by the crisis. Still, as of May 1st, 2020, many real estate segments have not been affected directly. REITs on the other hand, have been strongly affected by the crisis, and are down more than the market portfolio across the publicly traded U.S. markets. Reasons for this, as well as the potential long-term effects on the market, will also be discussed in the thesis.

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1 Introduction

1.1 Research question

Most mutual funds, hedge funds, and other large-cap investors have allocated a part of their portfolio in real estate. Typical pension funds allocate 6% of their portfolio to real estate, while typical hedge funds allocate 3.5% (Andonov, Eichholtz, & Kok, 2015). This thesis will explore the reasons why large-cap investors should choose to invest in real estate, as well as different strategies investors can apply when doing so. It will also look into the strategies that investors can apply for building a mixed-asset portfolio with a real estate component.

Hence, our research question is:

Why should large-cap investors include REITs in their mixed-asset portfolios?

To answer this, we will address the following sub-questions:

- What alternative ways of real estate investment exist, and what are the strengths and weaknesses of the different alternatives?
- Using modern portfolio theory, how much weight should be allocated to REITs in a mixed-asset portfolio?
- How can different sub-sectors of REITs contribute to portfolios?
- What investor types will benefit more or less from a larger real estate allocation?
- What effect can the ongoing COVID-19 crisis be expected to have on the real estate market, and the chosen portfolio?

1.2 Motivation

Real estate has always been a fundamental asset class. It is fundamental in ways many industries are not, in that people need real estate for a place to live, a place to work, and to recreate. Besides, companies need real estate for the production of goods, services, and logistics. Because real estate is considered essential and permanent, it is often regarded as less risky than stocks. Since the global financial crisis, many western countries have lowered their interest rates close to, or even below zero. The weak bond yields of today's economy make real estate investments even more interesting. We realize that real estate investments are perhaps more relevant now than ever and that

more asset managers potentially could benefit greatly from having more empirical analysis and clarity brought to the field. Because of this, we seek to discuss the various reasons to include real estate in multi-asset portfolios and to determine how this can be done successfully.

While working on the thesis, a global health crisis, COVID-19 hit the U.S. The number of infected people and deaths are rising quickly, and we are observing the pandemic affect more or less every part of our society. People are encouraged to stay in their homes, many businesses are shut down, workers are being laid off, and the general uncertainty is high. Not surprisingly in all this chaos, stock prices across more or less all asset classes are plunging. In this sudden bear market, most asset managers are seeing their portfolios lose value, and are more than normally looking for safe havens and hedges. Because of the imminent impact the COVID-19 crisis is causing the investors and portfolios analyzed in our thesis, we want to investigate the crisis' effect on the real estate sector as a whole, and with an extra focus on REIT investments and mixed-asset portfolios.

1.2.1 Motivation for focusing on REITs

There are several reasons for this thesis' focus on REITs. Technical reasons aside, REITs have emerged as an increasingly exciting financial asset. Its purpose to make diversified real estate investments more accessible for both institutional and retail investors is a clever way to expand the real estate investment pool and to make the market more liquid. The first REITs emerged in the USA in the 1960s, but the asset class has grown a lot in popularity over the last decades. This can be seen in the development of REIT sizes and the number of REITs. The total market capitalization of all REITS in the U.S. was USD 8.74bn in the year 1990. In January 2020, the market cap was more than 100 times bigger, totaling USD 1,300bn (Nareit, 2020a).

From a portfolio analysis stance, there are technical reasons why REITs are better suited than private market real estate in regards to comparison with other asset classes. This has to do with the price-making mechanisms of REITs contra private market investments. These technical reasons are elaborated in the theory chapter and under delimitations.

1.3 Delimitations

In 1971, Harris C. Friedman proved that Markowitz's mean-variance portfolio theory is applicable for real estate investments and mixed-asset portfolios as long as return and risk can be quantified (Friedman, 1971). For publicly traded real estate investment trusts (REITs), risk and return measures are just as quantifiable as for publicly traded stocks. Because of this, we largely focus on REITs for portfolio composition. Hence, the results of the quantitative analysis are only applicable for REITs, and should not be used as a proxy for the real estate market as a whole. However, private market investments will be included in the qualitative analysis.

To access the widest array of publicly-traded REITs and public real estate companies in different sub-industries, this thesis is limited to the U.S. market. Still, the findings will potentially apply to other similar markets.

The REITs used in the analysis are publicly traded on U.S stock exchanges NYSE, NASDAQ, and AMEX. It is recognized that when comparing these REITs to the stock market as a whole, the REITs are part of the market they are compared with. However, the REITs' market capitalization is small compared to the market as a whole. All the companies traded on the NYSE and NASDAQ exchanges have a combined market capitalization of approximately 40 trillion dollars (Nasdaq, 2019). Ergo, the market capitalization of the entire REIT segment amounts to about 3.25% of the total stock market, about the same weight as the largest individual corporations: Microsoft and Apple Inc., (Yahoo Finance, 2020b). Thus, the REIT returns will not be able to make a significant impact on the total stock market returns, and comparisons with the stock market are still viable.

1.3.1 COVID-19 related delimitations

This thesis was produced amidst the COVID-19 crisis. Because of this, the end outcome of the crisis is not known, and hence not part of the thesis. Because of this, all analysis of the long term impacts of COVID-19 are based on expert predictions and forecasts, and should not be seen as absolute facts. All discussion concerning the coronavirus' impact on the real estate market, as well as other markets, is based on the impact already seen at the beginning of May 2020, as well as reports, journals and other writings offering forecasts and expectations about the virus' effects, also produced prior to May 15th, 2020. This should be taken into consideration when reading the analysis and conclusions regarding the COVID-19 crisis and its potential aftermath.

2 Methodology

The methodology chapter seeks to answer how the thesis' research question and sub-questions will be answered. It is doing so by illuminating the process of examining the real world for empirical data that can be used for drawing general conclusions. Hence, the chapter will review the methodological entry to the thesis' collection of data, and provide some discussion about the selection of models and theories. It will then provide a review of the quality of the data collection.

2.1 Review of the data collection

When evaluating the quality of data, two central elements should be taken into consideration: Validity and reliability. Validity is defined as the extent a concept is accurately measured in a quantitative study (Heale & Twycross, 2015). Reliability describes the accuracy of a measurement. Hence, a reliable analysis can be repeated, by the same or other analysts, and the result will be the same (Bitsch Olsen, 2003). As extern analysts, without any inside information of the market or real estate industry, the analysis has been based on public information. In some instances, data that would have been helpful for the analysis is not available. In these instances, the analysis has to rely on less reliable data and/or assumptions. Such conditions affect the connection between the collected data and the thesis' conclusions negatively, hurting the validity of the conclusions. This is to some degree unavoidable, but the thesis' delimitations help to specify for what areas the conclusions are, and are not, applicable. This contributes to making the answers to the research questions more reliable and viable, despite the mentioned challenges.

As the thesis is dependent on publicly available information, another important element of the thesis' reliability is the controlling of extern sources. Part of this has been to minimize the use of internet articles as sources. The reason being, that the original source can be opaque or difficult to find, making the reliability weak. Many sources from the internet have been used, but these are transparent sources, where the author and date are cited, or where the author is deemed a trustworthy organization. Examples of the first are professors and renowned industry experts such as Dartmouth's Kenneth French, MIT's William Wheaton, and NYU's Aswath Damodaran. These professors have not only written books but journals and scientific articles. These articles are indeed considered highly reliable despite being found online. Examples of the latter are the SEC, Nareit, and State Street Global Advisors.

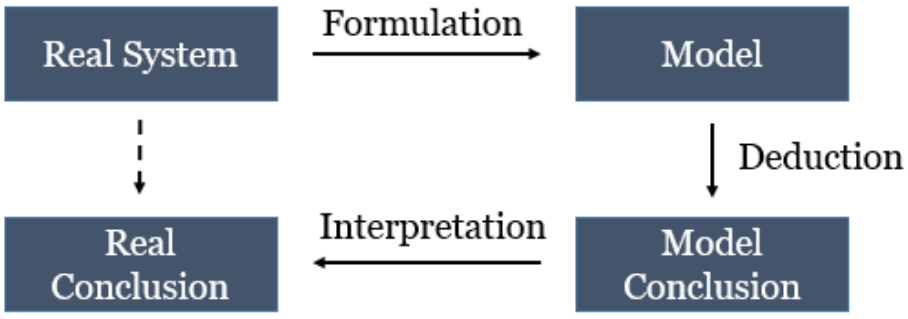
Even governmental and non-profit organizations can have biases or agendas, but the requirements and responsibility of these organizations make the authors of this thesis trust that the numbers and analyses provided by said corporations are reliable. Another element that helps to minimize the risk of bias, is the use of several sources supporting each analysis. The notion being that one source's reliability could be questionable, but if the same data is confirmed by other unrelated sources, the reliability of the data is significantly strengthened (Bitsch Olsen, 2003). This thesis strives to verify as much data as possible with the use of numerous unrelated sources throughout the analysis.

2.2 Models for use in research

To make conclusions and predictions based on historical observations, one has to rely on models. This segment will discuss modeling in broad terms and highlight the potential pitfalls in the modeling process.

A model, how it is used in this thesis, is a simplified representation of something in the real world. This usage implies that a model is always a representation that is less than perfect. Given there is something that calls for investigation in the real world, here called the "real system", and there is a "problem" related to the real system which calls for definite "conclusions", the modeling process can be depicted as in figure one (Phillips, Ravindran, & Solberg, 1976).

Figure 1: Process of modeling



Source: (Phillips, Ravindran, & Solberg, 1976)

The first step is the construction of the model itself; Formulation. This is based upon an inductive generalization and is a highly important part of the analysis. It requires decisions as to what aspects of the real system should be incorporated in the model, what can be left out, and what *assumptions* should be made. Because of these assumptions, it follows that the formulation step will include a certain amount of arbitrariness.

Once the formulation is made, the process gets more scientific. The "deduction" step involves computation and expressing a sequence of logical statements. This part of the problem will not be subject to differences in the analysts' opinion, as long as the assumptions of the model are well defined. It follows from this that nobody knowing the formulation and assumptions of the model should be able to question the model conclusion. In this thesis, the model conclusion includes absolute answers such as specific portfolio weights and returns of real estate, stocks, and bonds.

The model conclusion cannot, uncritically, provide absolute answers for the real system. That is why the last process of modeling is "Interpretation". This part of the process, just like the formulation, involves human judgment. This involves the consideration of the results of the model are realistic and plausible. It is important to review if any factors that have not been taken into consideration in the modulation could alter the conclusion. This means that aspects of the real system that were overlooked, ignored, or discarded in the formulation phase of the model may turn out to be important in the interpretation. Thus, it will improve a model to continuously reconsider and update the formulation thorough "testing and revision" (Ackoff, 1962). Readers are encouraged to consider this while interpreting the models presented in the thesis.

As the connection between the real system and the model is formulation and inductive generalization, Black swan events like the Covid-19 brings huge ramifications to the world. With such severe and atypical movements, models will typically do a poor job of estimating the consequences of the movement. Models that are built on historical data tend to give model conclusions that are easily transferable to real conclusions when the parameters continue to move similar to how they have done in the past. The historical input of this thesis' model, as well as any other model, does not have any historical scenarios resembling what is happening because of the COVID19 virus. Thus, the quantitative model made in this thesis, as well as other models used to

forecast the future based on historical data, will likely not be able to produce a credible forecast for the effects of the COVID-19 crisis. Because of this, the thesis will not use quantitative modeling to try to forecast the effects of COVID-19 on the real estate market. Instead, this highly relevant topic will be discussed as part of the qualitative analysis.

3 Theory

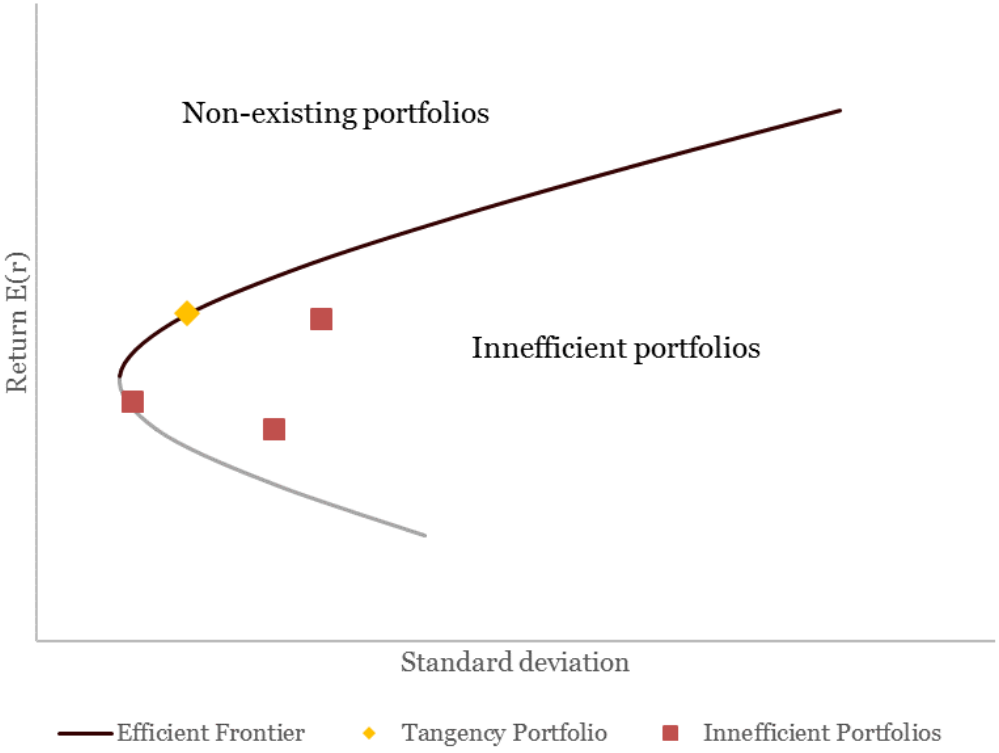
The theory chapter presents, explains, and discusses the core theories used in the thesis' further analysis. Hence, the chapter lays the theoretical foundation that the rest of the thesis is built on. Most of the theories discussed are from the field of finance and portfolio theory, but literature about real estate valuation and REITs are also explored.

3.1 Markowitz' Portfolio Theory

For the portfolio theory, the thesis assumes that investors seek to maximize their return for any given level of risk. Hence, their investment decisions are based on modern portfolio theory (MPT). This theory was introduced by Harry Markowitz in 1952. By creating a method for quantifying the risk and return of any combination of assets, Markowitz allows investors to construct the highest yielding portfolio for any risk preference, or the or the least risky portfolio for any return preference. This is also known as the mean-variance portfolio (MVP).

Markowitz's portfolio theory builds on the basic perception that a diversified portfolio is less risky than an undiversified one, because the value fluctuations of the assets in the portfolio to some extent will weigh each other out, thus reducing the combined variance. However, Markowitz takes the theory one step further by quantifying the diversification benefit of portfolios by analyzing the variance and covariance of the assets in the portfolio (Markowitz, 1952). All possible combinations of assets that generate maximum return per risk create portfolios located on "the efficient frontier", and are regarded as efficient portfolios. The efficient frontier is illustrated in figure two. As the efficient frontier represents the optimal portfolios in the tradeoff between risk and return, it is impossible to find a portfolio that is above the frontier. The portfolios under the frontier are not compensated sufficiently for their risk and are therefore inefficient portfolios.

Figure 2: Efficient Frontier



Source: (Markowitz, 1952)

Markowitz's portfolio theory is widely accepted but has a drawback in its assumption of a normal distribution of returns. Standard deviation is the only measure of risk in the model and is measured as movements in both directions. Thus, with a skewed distribution, tail losses will not be considered.

3.2 Sharpe

The risk-return relationship described by Markowitz was later used as a performance measurement for mutual funds by William Sharpe (Sharpe W. F., 1966). Sharpe named this the "reward-to-variability-ratio" but it is widely known as the "Sharpe ratio". The Sharpe ratio provides a risk-adjusted performance measure by dividing the excess return of a risky security by the standard deviation of said security.

$$Sharpe\ Ratio = \frac{portfolio\ return - risk\ free\ rate}{portfolio\ volatility}$$

Thus, the ratio measures how well investors are compensated for the risk they are taking. It is one of the most commonly used ratios for comparing portfolios. Furthermore, the Sharpe ratio is used for building portfolios with the Markowitz method, as the combination of assets maximizing the Sharpe ratio creates the tangency portfolio, the point where the capital allocation line (CAL) meets the efficient frontier.

A drawback of the Sharpe ratio is that it, just like the MPT, assumes normally distributed returns. Furthermore, the Sharpe ratio produces a numerical value of the return to risk relationship, which can be difficult to interpret without comparison with other assets.

3.3 Friedman

Friedman (1971) shows that the models of Markowitz's modern portfolio theory, used for constructing stock-portfolios, also can be applied for real estate and mixed-asset portfolios. The concept of selecting real estate assets are identical to the selection of stocks, as long as the risk and return can be quantified.

3.4 CAPM

Markowitz's modern portfolio theory laid the foundation for the development of one of the first and most influential factor models, the *Capital Asset Pricing Model* (CAPM). The CAPM model is based on the work of William Sharpe (1964), John Lintner (1965), and Jan Mossin (1966) who each separately published papers that contributed to the formulation of the model. The model is still widely used to find the cost of capital when valuing assets.

The model differentiates the risk of an asset, between firm-specific risk and market risk. Market risk, called systematic risk by Sharpe, is defined as the risk that it is not possible to eliminate by diversification. The model assumes the investor is fully diversified and therefore has eliminated all firm-specific risk and deems only systematic risk as a relevant risk measure.

The CAPM model describes the linear relationship between systematic risk and expected return. It assumes that investors expect to be compensated with a higher

expected return for taking on more risk. Systematic risk is usually denoted as *beta* in the CAPM model.

The CAPM prices assets based on two risks that investors face in the model: time value of money and sensitivity to markets risk. The formula compensates investors for the time value of money by adding the risk-free rate as a minimum expected rate of return. Exposure to systematic risk is compensated by adding a risk premium on the excess return on the market portfolio. This risk premium is denoted as beta and is a measure of sensitivity to volatility in the market portfolio. Market beta is given by the formula:

$$\beta_i = \frac{cov(r_i, r_M)}{var(r_M)}$$

The CAPM formula is defined as:

$$E[r_i\,] = r_f + \beta_i\ \left(E[r_M\,] - r_f\,\right)$$

Where:

$E[r_i] = Expected\ return\ of\ asset\ (i)$ $\qquad$ $r_f = Risk\ free\ rate$

$E[r_M] = Expected\ return\ of\ market\ portfolio$ $\qquad$ $\beta_i = Beta\ of\ asset\ (i)$

The market portfolio has a beta of 1 and is the average beta of the market. A higher than 1 indicates a higher sensitivity towards volatility in the market portfolio than average. An asset with a beta of 1,5 will increase 150 basis points when the market increases 100 basis points. In the CAPM model a higher beta indicates a riskier asset and requires a higher return.

The CAPM model is built on several underlying assumptions.

1. There are no transaction costs or taxes
2. All assets are marketable and can be divided into infinitely small parts.
3. All investors are price takers and do not affect the price by their own trading.
4. Investors act rationally, making decisions solely on risk-return assessment.
5. Investors can, without limitation, engage in short-sale.
6. Investors can lend and borrow unlimitedly at the risk-free rate.
7. All investors have homogenous time frames and expectations towards returns, variances, and covariances.

The assumptions imply that all investors agree on the risk-free rate and the efficient frontier of risky assets (Munk, 2018, s. 293). All investors, therefore, invest in the market portfolio and the risk-free asset.

The CAPM model has been criticized for being untestable because the true market portfolio is practically unobservable. Roll (1977) states that stock exchange indices are only a partial measure of the true global market portfolio and that it would need to consist of every security in the world to be true. The CAPM model has also been criticized by several researchers, among them Fama and French (1992), for being too simplistic to describe the cross-section of expected returns.

3.5 Multifactor models

3.5.1 Fama & French Three-Factor Model

Fama and French introduced in 1992 a multi-factor model that similarly to CAPM aims to predict the expected return of stocks. Fama and French expanded the model with two additional factors intended for explaining patterns in average returns that were not explained by the CAPM model.

By the late 1980s several researchers had found market patterns that contradicted the CAPM model. Banz (1981) identified a negative relationship between the size of a company and average returns. Meaning that firms with large market capitalization perform on average worse than firms with a smaller market capitalization. Small firms had average returns that were too high according to the CAPM model, given their beta estimates.

Stattman (1980) and Rosenberg, Reid, and Lanstein (1985) discover evidence of another anomaly that is contradicting CAPM. Their research show that there is a positive relationship between the average returns of US stocks and the firm's book-to-market ratio. Both anomalies in expected return that researchers have found confirm that there are other characteristics than just sensitivity to the market portfolio, which explains the expected return of stocks and that CAPM is not a sufficient model.

Fama & French's three-factor (FF3) model uses two additional factors for size and value in addition to the market factor of CAPM, to better explain stock performance. The two new factors are constructed by creating two portfolios that mimic the

performance of size and value stocks. The portfolios are constructed by sorting stocks into two *Size* groups and three *Value* groups (independent 2x3 sorts). The *Size* group is divided by the median market cap of the market (Fama & French used NYSE stocks). The *Value* group is broken up by the 30th and 70th percentile of B/M for stocks in the market. The *Size* factor, called *small-minus-big* (SMB), is the average of the three small stock portfolio returns minus the average of the three big stock portfolio returns. The *Value* factor, *high-minus-low* (HML), is the average return of the two high *B/M*-portfolios minus the two low *B/M*-portfolios.

The two new factors are used similarly to how the stocks beta coefficient is used to predict the expected returns in the CAPM model. Stocks have different sensitivity towards SMB and HML factors, and the coefficient to these variables will affect the expected return of individual stocks in the FF3 model. The three-factor model time series regression is formulated as (Fama & French, 1996):

$$R_{i,t} - R_{f,t} = a_i + \beta_i\left(R_{Mt} - R_{f,t}\right) + s_i SMB_t + h_i HML_t + e_{i,t}$$

R_{it}	= return of a stock or portfolio at time t	SMB	= size premium
$R_{f,t}$	= risk-free rate of return at time t	s_i	= size factor exposure
R_{Mt}	= return of market portfolio at time t	HML	= value premium
β_i	= beta of asset (i)(market factor exposure)	h_i	= value factor exposure
a_i	= intercept (zero if factors capture all variation)	$e_{i,t}$	= residuals (assumed=0)

Testing of the model by Fama and French found that the FF3-model had an average $R^2$of 0,93 on regressions on 25 size-value portfolios (Fama & French, 1996). This means that on average 93% of the variation in the portfolio was explained by the three factors. They also find that the addition of the two factors captures most of the patterns in average return that CAPM did not explain.

Fama and French (1993) suggest the model find any application that requires estimates of expected stock returns. This includes estimating the cost of capital and measuring abnormal returns. In 1996, Fama and French published evidence of the three-factor model's superior explanation of returns compared to the CAPM model.

Their research shows that their model produces three to five times fewer pricing errors than the CAPM model (Fama & French, 1996).

The FF3 model has been criticized for being an incomplete model for expected returns, and several researchers have proposed adding additional factors to the model. The most noteworthy works are by Mark Carhart (1997) and Fama & French themselves who expand their model in response to criticism in 2015.

3.5.2 Fama & French Five-Factor model

Several researchers have published evidence of shortcomings in the three-factor model, and that there are several prominent patterns in average returns that the model does not explain. Novy-Marx (2013) Titman, Wei, and Xie (2004) and others have found evidence that the three factors miss much of the variation in average returns related to profitability and investment.

The published evidence motivated Fama and French themselves to update and add additional factors to their model. Novy-Marx (2013) showed that firms with a high profitability-to-book-equity ratio earn significantly higher average returns than unprofitable firms. Titman et al., (2004) found that firms that invest aggressively subsequently achieve negative benchmark-adjusted returns. In response to this, Fama and French include two new factors for profitability and investment, and thereby creating a five-factor model. (Fama & French, 2015).

The profitability factor is constructed as the difference between the returns on diversified portfolios of stocks with robust and weak profitability and is called *Robust-Minus-Weak* (RMW). Profitability is measured by the ratio of a firm's profits to its assets. Profits are the annual revenues minus cost of goods sold, interest, selling, general and administrative expenses, all is then divided by book equity.

The investment portfolio is calculated as the difference between returns on diversified portfolios of stock with high and low investments and is called *Conservative-Minus - Aggressive* (CMA). A firm's investment level is determined by its growth in total assets in the previous fiscal year.

In Fama and French's paper introducing the five-factor model, the factor portfolios are constructed in three different ways. The portfolios that are used in this paper are sorted as 2×3. Where the size factor is divided into two, and the remaining are sorted in three. In practice, stocks on the NYSE are first divided into two, along with the

median market value into groups of small and big firms. For each size, group stocks are again sorted into three groups by the 30th and 70th percentile, for high, neutral, and low according to the specific ratios. The *HML, RMW,* and *CMA* portfolios are the average return on the two high portfolios minus the two small portfolios, and the neutral stocks are excluded. RMW, for example, is calculated as:

$$RMW = 1/2(Small\ Robust + Big\ Robust) - 1/2(Small\ Weak + Big\ Weak)$$

Since the other three factors are sorted on size, the SMB is divided into three portfolios, each sorted on the three other factors. The profitability size factor is calculated as:

$$SMB_{(RMW)} = 1/3(Small\ Robust + Small\ Neutral + Small\ Weak) - 1/3(Big\ Robust + Big\ Neutral + Big\ Weak)$$

The full *SMB* is the average return of the three SMB portfolios:

$$SMB = 1/3\left(SMB_{(HML)} + SMB_{(RMW)} + SMB_{(CMA)}\right)$$

The five-factor model time series regression equation is:

$$R_{i,t} - R_{f,t} = a_i + \beta_i\left(R_{Mt} - R_{f,t}\right) + s_i SMB_t + h_i HML_t + r_i RMW + c_i CMA + e_{i,t}$$

Where r_i and c_i are the factor exposure to the profitability and investment portfolios. Fama and French found the five-factor model to explain 71%-94% of the cross-section variance of expected return for the size, value, profitability, and investment portfolios.

3.5.3 Carhart's Four-Factor model

Fama and French's five-factor model has been criticized for leaving out a momentum factor (Blitz, 2018). The momentum factor of Carhart is widely accepted within academia and is one of the most notable expansions of the original three-factor model. According to ROBECO (2018) many researchers will end up adding a momentum factor to the five-factor model, which is why we in this paper also will include a momentum factor.

Research by Jegadeesh and Titman (1993) show that strategies that go long on past winners and short past losers realize significant abnormal returns. The abnormal returns were found to not be due to their systematic risk or other common factors (such as SMB or HML). The discovered effect on returns is only present short-term

and dissipates within two years. Based on these findings, Carhart (1997) developed a model that added a momentum factor to the Fama & French three-factor model. The momentum portfolio is constructed by Carhart as the average equal-weighted return of 30% best performing firms the past 11 months minus the 30% worst-performing stocks in the same period. The portfolio includes all NYSE, AMEX, and Nasdaq stock, and are re-formed monthly to get a rolling momentum effect.

The time series regression of the new model has the equation:

$$R_{i,t} - R_{f,t} = a_i + \beta_i\left(R_{Mt} - R_{f,t}\right) + s_i SMB_t + h_i HML_t + \rho_i MOM + e_{i,t}$$

Where *MOM* is the momentum factor, and ρ_i is the momentum factor exposure. The momentum factor is also sometimes referred to as *UMD* for up-minus-down.

3.6 Real Estate Investment Trusts (REITs)

Creating a diversified real estate portfolio is an expensive, labor-intensive, and time-consuming process. Because of this, REITs were established in the U.S. in the 1960s to give retail investors access to diversified commercial real estate. It does so by pooling commercial real estate into financial entities and allowing investors to buy shares, thus lowering the bar for people and institutions to invest. Essentially, a REIT is a company that owns and operates rent-generating commercial properties. REITs can either buy or develop its properties -the important thing is that it operates them. Thus, real estate developers, construction companies, and other companies developing properties for sale will by law not qualify as REITs. Most REITs own equity, typically financed with 40-60% debt (Sando, 2012) but some REITs also invest in real estate debt and mortgages.

The first REIT index was created in 1977. Since then, REITs have had an average yearly return of 10.8%. Over the same period, the S&P 500's yearly return was 11.0% (Sando, 2012). In other words, based on historical returns, listed real estate and listed stocks seem to offer more or less identical returns in the long run. However, there is a big difference in the payout structure of these returns: Most REITs generate significantly higher dividend yields and lower value growth than typical stocks. Out of the ~11% annual returns generated from REITs and the S&P500, the REIT returns consisted of 76% dividends and 24% value growth, while the S&P 500 returns were 28% dividends

and 72% value growth (Sando, 2012). This is no coincidence, as most investors that buy rent-generating properties are partly doing so because they desire a consistent stream of cash flows over a long period of time. As REITs function as a way for stockholders to invest in rent-generating real estate, it should also provide similar cash flows. This is also embedded in the very definition of a REIT. According to the Securities and Exchange Commission (SEC), "To qualify as a REIT, a company must distribute at least 90 percent of its taxable income to shareholders annually in the form of dividends" (SEC, 2011). In addition to this, REITs are required to invest at least 75% of its total assets in real estate or cash and derive at least 75% of its gross income from real estate related business. If these criteria are met, REITs are exempt from paying corporate tax in the U.S.

3.7 Valuing Real Estate

Real estate assets can in many ways be valued with the same metrics as stocks. For instance, multiples, yields, and growth rates are all used for valuing real estate. However, there are also metrics unique to real estate.

Fundamentally, the revenue from all real estate is a combination of value growth and direct revenue. Combined, these two income streams comprise the total revenue from a property. The direct revenue comes from rent payments that typically are paid every month, quarter, or year. The revenue from value growth is the change in the property's market value over the holding period. This value growth is a result of the change in the market rent, change in the yield, or change in the residual value (the value appreciation that cannot be explained by the two other factors). This includes goodwill and expectations about future earnings (Syz, 2008).

3.7.1 Damodaran 2012

Some real estate specialists have historically argued that real estate is too different from stocks, and needs to be valued with unique methods. Aswath Damodaran (2012) presents the view that the discounted cash flow method commonly used to value publicly traded stocks also is the best method for real estate assets. Fundamentally, he says, the value of any cash flow generating asset should be the present value of the expected cash flows generated by the said asset. I.e. the value of a real estate asset is determined by the cash flows it generates, the certainty associated with these cash

flows, and the expected growth in these cash flows. The higher the level, growth, and certainty of an asset's future cash flows, the greater the asset value, other things remaining equal (Damodaran, 2012).

To use the DCF-method for real estate, a few extra aspects need to be considered both when quantifying the risks and estimating a discount rate, and when estimating the right cash flows for the right lifetime.

When discounting cash flows, it is normal to use the weighted average cost of capital (WACC). This principle also works for real estate. The WACC is given as:

$$WACC = r_E * \frac{E}{V} + r_D * \frac{D}{V} * (1 - T)$$

The cost of debt (r_D) is the rate at which the investor can borrow money. E/V is the equity ratio, D/V is the debt ratio and T is the corporate tax rate. These factors work the same way for real as financial assets, as they merely concern the financing of the asset. The cost of equity (r_E) however, leaves more room for discussion. The cost of equity for an investment is given by the CAPM formula:

$$E[r_i\,] = r_f + \beta_i\ \left(E[r_M\,] - r_f\,\right)$$

Hence, it depends on the risk-free rate (r_f), the asset's correlation with the market (β), and the asset's risk premium $\left(r_m - r_f\right)$. The cost of equity can also be found by the arbitrage pricing model. Nevertheless, both CAPM and the arbitrage pricing model define the risk of any asset as the portion of that asset's variance that cannot be mitigated through diversification. For this risk definition to be viable, it is assumed that the marginal investor in the asset keeps a well-diversified portfolio.

In regards to real estate investments, this view is contested by many. The notion is that real estate investments tend to be so large that many real estate investors will have difficulties diversifying sufficiently. If real estate investors do not have diversified portfolios, then the assumption that only non-diversifiable risk is rewarded does not stand. In that case, CAPM and the arbitrage pricing model are unsuitable for estimating the cost of equity.

Damodaran (2012) on the other hand, argues that the marginal real estate investor should be assumed to hold a well-diversified portfolio. There are primarily three

arguments for this. The first is that the investors that are heavily invested in real estate and not diversified, are doing so by choice because they believe in the sector and/or because they have specialized knowledge in the field they want to leverage. This is no different from investors whose portfolios are heavily weighted in a specific industry, for instance healthcare or tech stocks. The second argument is that the marginal investor in real estate, just as for stocks, increasingly are becoming large institutional investors such as mutual funds and life companies, who are making investment decisions on behalf of aggregated funds. These investors often have hundreds and even thousands of billions of dollars in assets under management, which is more than enough to keep a diversified portfolio, and the transaction costs low. The last argument is that although indeed, real estate assets often are large investments, they are often split up into smaller pieces. This allows investors to buy shares of property or real estate portfolios, such as real estate companies and REITs. Such vehicles allow smaller funds and even retail investors to include real estate assets in diversified portfolios.

Based on this, Damodaran concludes that the CAPM can be used to find the cost of equity to be used as a discount rate for real estate valuations. Still, the pricing mechanisms of real estate is different from that of stocks. This has to do with real estate's low liquidity, which creates an issue with the credibility of the market beta of private market real estate assets. This issue will be discussed more thoroughly under the *REITs VS direct real estate* section in chapter five.

4 Data

The data chapter represents the data used in the quantitative analysis. It does so by explaining the indexes and assets that are used for and why it is chosen. It also presents where the data has been collected, making it possible for other researchers to access the same data, and to gather updated data of the same indexes.

4.1 Stock Market

This thesis assumes that the market value of publicly traded companies accurately represents the fundamental value of the companies. For this to be true, all publicly available information needs to be reflected in the stock prices. Thus, the thesis assumes that the public exchanges for both stocks, REITs, and bonds are efficient markets where every relevant change in the companies, the market, and the macroeconomic environment promptly will be reflected in the market prices.

Stocks are traded continuously – Their trading frequency varies over time and between stocks, but most S&P 500 constituents are traded thousands of times per day. This means their correct market price is updated just as often. Stocks are also usually traded on the exchange for extended periods of time, providing plenty of data for comparison and calculations.

For the quantitative analysis, this historical data is obtained from databases. As the thesis focuses on the USA, the U.S. stock market is used as a benchmark. Historical values for the equity market are from the Center for Research in Security Prices, LLC (CRSP). This data includes the monthly returns of every stock listed on the New York Stock Exchange (NYSE) and NASDAQ. It also includes all the stocks listed on the American Stock Exchange (AMEX) for years prior to 2008, when the exchange was bought and incorporated into the NYSE. These US stock market returns are downloaded from Kenneth French's database; "Kenneth R. French – Data Library" (French, 2020). The returns of the indices are value-weighted based on the value of the individual stocks on the market and are adjusted for dividends and stock splits.

Portfolios used for Fama-French analysis are also downloaded from the Kenneth French's database. These portfolios are constructed as described in the Fama- French three- and five-factor model sections under theory.

For the COVID-19 related analysis, all stocks on NASDAQ and NYSE are still used as the benchmark for the stock market. For this part of the quantitative analysis, daily values and volatility are used instead of monthly. This is to get more data points, as the analysis is done over a shorter period, from February 1st to April 30th.

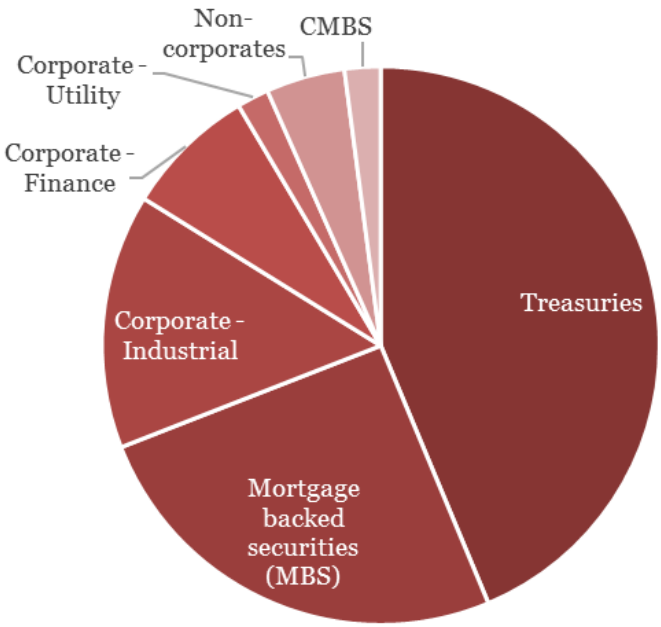
4.2 Bond market

Most large-cap investors have a significant part of their funds invested in bonds, making bond returns important to analyze and compare with real estate. To represent bond investments, this thesis uses an index to capture the entire U.S. bond market in an unbiased way. The most representative index for this is the Barclays Capital U.S. Aggregate Bond Index (AGG). This index tracks the performance of the investment grade, U.S. dollar-denominated, fixed-rate bond market. The index is the most commonly used benchmark for analysts and bond traders and is used by more than 90% of U.S bond investors (State Street Global Advisors, 2020). The historical return

and yield data for the AGG can be obtained from numerous databases such as Yahoo Finance (Yahoo Finance, 2020).

The AGG consists of more than 8,000 bonds, treasuries, mortgage-backed securities, and corporate bonds of different maturities. The weights of the different constituents as of April 2020 can be found in figure three.

Figure 3: AGG Index constituents



Source: (State Street Global Advisors, 2020)

For the COVID-19 related analysis, the AGG is still used as the benchmark for the stock market. For this part of the quantitative analysis, daily values and volatility are used instead of monthly, just as for the stock market data.

In the factor analysis the 10-year constant maturity treasury bond rate is used as a factor for interest rate exposure. The 10-year treasury rate of return is downloaded from FRED (Board of Governors of the Federal Reserve System, 2020).

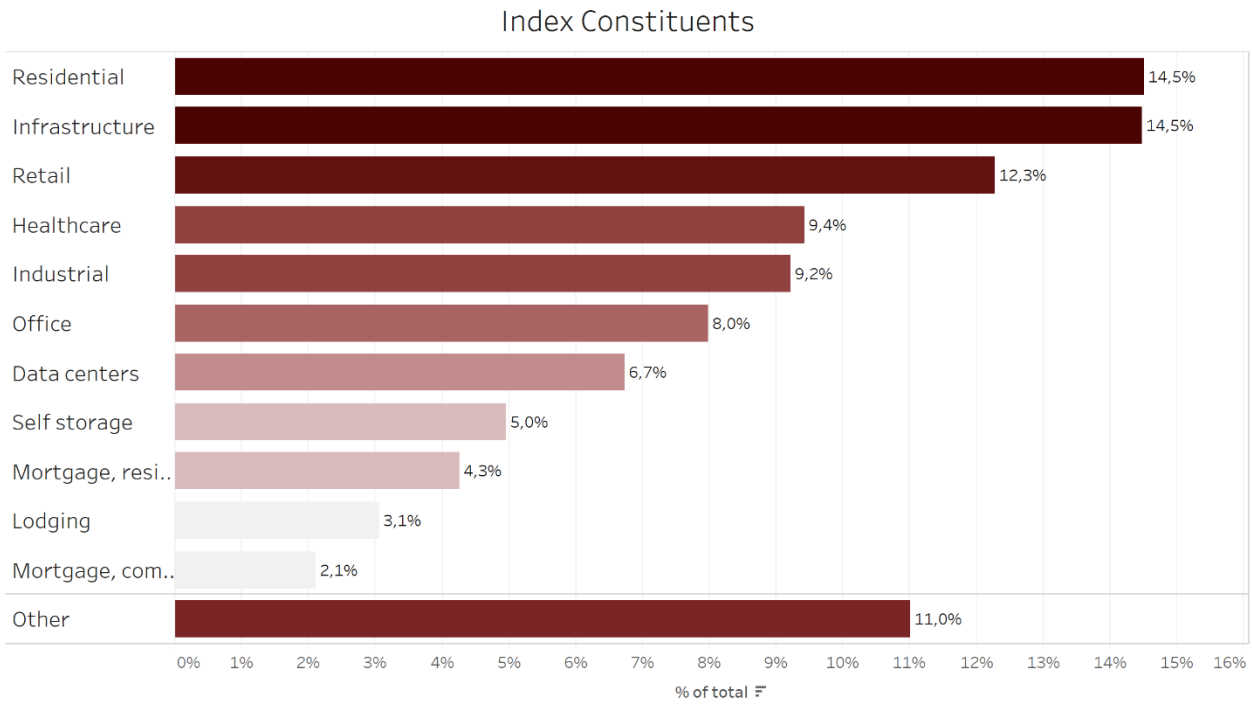
4.3 Real Estate Market

The U.S. has many publicly-traded REITs and indexes for different REIT sectors, making the historical return from these REITS almost as easy to find as for “regular” stocks. To capture as much of the REIT market as possible, this article uses indexes comprised of REITs for its analysis. These indexes are delivered from Nareit. The FTSE Nareit All REITs Index includes all Nareit-membered REITs listed on NYSE, AMEX, or the NASDAQ National Market List. The index is not free float-adjusted and has no requirement for minimum size or liquidity. The returns used are dividend-adjusted, which is extra important as the majority of REIT returns come from dividend payments.

The index is built up of 20 indexes specialized in 12 unique real estate sectors. In total, these 20 indexes are comprised of 219 REITs. The All REITs index is the market capitalization based weighted average of these 219 REITs (Nareit, 2020a). In total, there are 293 REITs traded on the major stock exchanges in the U.S., meaning the majority of all publicly-traded REITs in the U.S are part of the All REIT index, making it representative of the market (REITnotes, 2020), (Nareit, 2020b). The distribution between sectors in this index, sorted after market capitalization, can be found in figure four. Most of Nareit’s segment indexes have data from the year 1994. Because of this, the analysis starts on 01/01/1994.

As for the COVID-19 related analysis, the same index, FTSE Nareit ALL REITs index is used to represent the impact of the virus on the REITs market. For this part of the quantitative analysis, daily returns and volatility are used instead of monthly, just as for the stock and bond data.

Figure 4: Nareit ALL REIT Index, segment weights



Source: (Nareit, 2020a)

Over the years, several additions have been added to the index. In 1994, the index consisted of nine segments: Office REITs, which are owning and operating office space. Industrial REITs, which are mainly owning terminals for logistics but also some properties in connection to factories and production of goods. Retail REITs comprise shopping malls, high street retailers, and some REITs with connection to specific retailer brands. Residential is the biggest category, and holds REITs specializing in apartment buildings, single-family homes, and manufactured homes. Diversified holds REITs who are diversified within themselves. Lodging REITs own hotels and resorts. Health care REITs hold hospitals, office space in connection to hospitals, assisted living facilities, medical labs, and research facilities. Self-storage REITs own storage facilities including vehicle storage, climate-controlled storage, and document storage for businesses.

In January 2000, mortgage REITs were added to the index. These are split into commercial and residential mortgages and differ from the other REITs in that they own collateralized mortgage debt, and not equity in properties. Timber REITs were added to the index in 2010. This relatively small sector sticks out from the others in that it doesn't own buildings, but large pieces of woodlands. Infrastructure was added

in 2012 and is now the second biggest sector in the index. The largest segments within infra-REITs are cell towers, fiber-optic cable networks, and power grids. The latest extension was in 2015 when data centers and specialty REITs were added to the index. Data centers have been an important contribution because of their marvelous growth in pace with the recent technological advancements. Specialty REITs is an interesting segment in that it is fairly diversified within itself. The segment includes REITs that specialize in high-security art storage, prisons, farmland, and golf resorts among other areas. The largest part of the segment however, is casino properties. The list of the ten largest REITs in the Nareit All REIT Index by market cap and sector can be found in figure five.

Figure 5: Nareit ALL REIT Index, Biggest constituents (biggest REITs)

Company	Sector	Market cap (USDb)
American Tower Corp	Infrastructure (cell towers)	102,4
Crown Castle International	Infrastructure (cell towers)	62,3
Prologis Inc.	Industrial (logistics)	58,6
Equinix Inc.	Data centers	50,3
Simon Property Group	Retail (shopping	41,1
Public Storage	Storage	39,1
Welltower Inc.	Healthcare (Hospitals and assisted living)	34,4
Equity Residential	Residential (apartments)	30,8
AvalonBay Communities Inc.	Residential (apartments)	30,2
SBA Communications	Infrastructure (cell towers)	28,2

Source: (Nareit, 2020a)

5 Analysis

In the analysis chapter, research is done and analysis is conducted, built on the theories presented in the previous chapter. This is done to investigate the thesis statement and provide perspectives and answers to the sub-questions. The analysis is divided into two parts: a qualitative analysis and a quantitative analysis.

5.1 Qualitative analysis

The qualitative analysis is the more theoretical of the two. This segment does not analyze and interpret raw data but is based on the works of other academics. In that sense, it is mostly meta-analysis. The exception to this is the independent analysis of the housing data done as part of the COVID-19 related analysis. The analysis explores the different ways to invest in real estate, the portfolios of some prominent asset managers, real estate's typical reactions to macroeconomic factors, and a thorough analysis of the COVID-19 crisis' effect on different segments, including a discussion of potential short and long term effects.

5.1.1 REITs VS direct real estate investments

Considering real estate solely as a financial asset, the main difference between real estate and stocks is perhaps the price-making mechanisms. The lion's share of real estate is not traded on an exchange; it is private properties switching hands. For commercial real estate, this is done much like how people are selling and buying their homes, only on a larger scale: Both the seller and the buyer hire brokers and lawyers and perhaps analysts, who make their value-estimates for the property. For a sought-after property, there might be a bidding war, where the buyer willing to pay the most gets to buy the property. If fewer parties are interested, the transaction price will be set as a compromise between the seller's and the buyer's estimated value, essentially their bid/ask price. When properties are bought like this, on behalf of an investor or fund, it is called a direct investment. The mechanisms of such a transaction, at its core, are not that different from when a stock is bought. The main difference is that stock, in most cases, represents a small share of a company. Thus, listed companies often have millions of shares on the market, allowing the company to be traded several times per day, hour, or even second. This way, the actual market price is updated continuously. This makes historical returns of listed stocks highly accessible for analysis.

As for direct real estate, the historical returns are a little more complex to find. As there is not a small percentage of the property that is bought and sold, but 100% of the property, the same property will naturally not be bought and sold often, making properties illiquid assets. Because of this, the price-making mechanisms are somewhat different. As the historical trading prices for a single property are scarce, property prices have to rely on the recent pricing of similar buildings. For instance, the price of a recently sold Downtown Chicago office building will be used as a proxy to value a similar Downtown Chicago office building. This way of estimating value is called appraisal. This is not only used for single assets; several real estate indexes are also based on appraisals. These could be indexes for location and category specified properties, for instance an index for multi-family homes in Los Angeles or high street retail properties in Manhattan. Pooled together, these indexes are used by many as a proxy for the entire real estate market, local as well as aggregated (Damodaran, 2012). Appraisals work well as a way of estimating the value of a specific property, but there are two reasons why they tend to give inaccurate estimates for market returns.

The first reason has to do with the very method of appraising market returns. It will indirectly assume that all properties in the same area and the same category are worth the same. As parameters such as construction quality, location, floor planning, and age impact property values significantly, appraisals prove inaccurate. Rebel A. Cole and Susanne E. Cannon from Chicago University studied the accuracy of real estate appraisals based on 25 years of appraisals and actual property transactions from NCREIFs sales data. The data was collected from 1984 to 2010, a period containing two up and down cycles in the market. They found that appraisals on average are more than 10% above or below the following sales price. They also found that even in a portfolio context where positive and negative errors are offsetting each other, the appraisals were more than five percent off (Cannon & Cole, 2011).

The second reason has to do with how often these appraisals are done. NCREIF's National Property Index (NPI) makes its appraisals quarterly (Cannon & Cole, 2011). This creates a smoothed return as short-term volatility will not be captured. Hence, appraisal-based indexes such as the NPI and non-public real estate trusts called Comingled Real Estate Funds (CREFs) tend to underestimate the true volatility of real estate assets and markets. As a result, if appraisal-based data is used as a proxy to calculate the return and volatility of the real estate market, analysts might find real

estate to seem overly attractive. Because of this, appraisal-based indexes will not be used in the quantitative analysis of this thesis.

Publicly traded REITs will not have this problem, as they are constantly traded like any other stock. Thus, REITs are far more usable for comparing with other asset classes. Still, there is a problem with using REITs as a proxy for the real estate market as a whole, as properties owned by REITs may not be representative of all real estate. This is because REITs tend to own certain types of buildings and certain property classes more frequently, and often hold buildings with higher than average quality and standard. Additionally, the securitization of real estate and mortgages in REIT portfolios could cause deviations between REIT returns and real estate returns (Damodaran, 2012). Looking at historical returns from REITS, CREFs, and the stock market, it is a clear tendency that assets with appraisal-based valuations such as CREFs and non-listed real estate, in general, have lower volatility associated with them than publicly-traded REITs. The data also shows that REITs have a higher correlation with the stock market than the non-publicly traded assets, indicating that REITs historically have not been a good proxy for the real estate market as a whole (Damodaran, 2012).

In separate and more recent research, the European Public Real Estate Association (ERPA) studied the FTSE EPRA Nareit indexes representing global publicly-traded REITs, and MSCI indexes of institutional real estate holdings representing the direct real estate. To adjust for differences in leverage, all returns are unlevered. To compensate for the smoothed returns created by quarterly appraisals, direct investment returns are de-smoothed. The analysis then considers returns in the period from 1998 to 2017. Econometric analysis is conducted on the data to find returns, volatilities, and correlations. A perhaps surprising find of this analysis was that the un-leveraging of REITs had an insignificantly small effect on the correlation with direct real estate (European Public Real Estate Association , 2019). Hence, for simplicity, this thesis will not unlever any returns in its analysis.

Considering the indexed returns from listed American REITs and American direct real estate in figure six below, the co-movement is evident. The two asset classes seem to have been especially dependent on each other until the 2008 financial crisis. This crisis had a larger effect on the direct market than on REITs. After REITs and direct real estate turned better in 2009, the two asset classes have moved somewhat equally. Still,

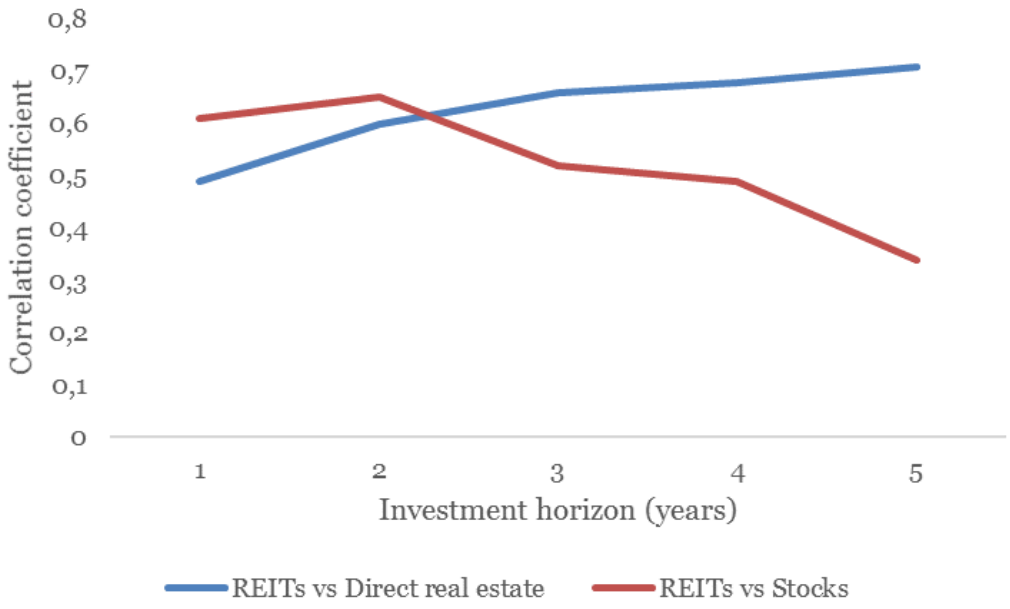
the direct real estate has been consistently below REITs with about as much as the extra loss direct suffered compared to REITs in 2008. The two asset classes show some fluctuations, but the long term trends are corresponding.

Figure 6: Indexed returns of listed real estate and direct real estate, U.S.

Source: (European Public Real Estate Association , 2019)

This long term similarity between REITs and direct real estate is confirmed by correlations. As illustrated by the blue line in figure seven below, the correlation coefficient was a little under 0.5 for investment horizons of one year. The correlation is consistently increasing over time and is 0.7 for five-year horizons. Doing the same analysis on REITs compared to the stock market, the opposite trend is observed. ERPA's analysis shows that REITs have a high correlation of 0.60 over one year and a much lower correlation of 0.34 for five-year investments. Historically, REITs have had a higher correlation with stocks for horizons up to about two years. For horizons over two years, REITs have been correlating more with direct real estate.

Figure 7: Correlations between REITs and direct real estate, and REITs and stocks over time



Source: (Hoesli & Oikarinen, 2019)

Based on this, ERPA concludes that long term returns from REITs correlate more with the underlying property market than with the stock market. But in the short term, REITs correlate more with the stock market and less with the direct real estate market (Hoesli & Oikarinen, 2019).

CBRE adds to this theory by arguing that especially during large market shifts, REITs tend not to be priced in line with their underlying asset value. This has been more evident in the recent bull market after 2008, as a larger share of all stocks is held by ETFs and index funds. This also applies to REITs, whose majority of shares are held by ETFs and large mutual funds such as the ones described in the next segment. These funds tend to invest based on broader market conditions rather than the net asset value or implied capitalization rate of the REITs' portfolio of properties. In fact, they find that only 15% of REIT shares are held by real estate dedicated investors who analyze the properties at a detailed level (CBRE, 2020).

In short, REITs work well as a way of making real estate investments more diversified. It also allows investors to get exposure to the real estate market without investing in the illiquid direct market. In return for being more liquid, REITs are also more volatile, as they are traded more often, and are part of other types of investors' portfolios.

Because of these findings, this thesis will focus on REITs for the portfolio building and main analysis, and not real estate as a whole. As REITs are proven often to deviate from the underlying property values, the discoveries and conclusions made from analyzing REITs in this thesis will not be used to draw conclusions on behalf of direct real estate.

5.1.2 Analysis of existing asset managers

Analysis of how typical institutional asset managers allocate money between asset classes, and how they invest in real estate, can give important insight into what strategies have worked well in the past. It also serves as a benchmark for this article's quantitative analysis, as it provides a solid foundation for comparison.

5.1.2.1 Investment managers

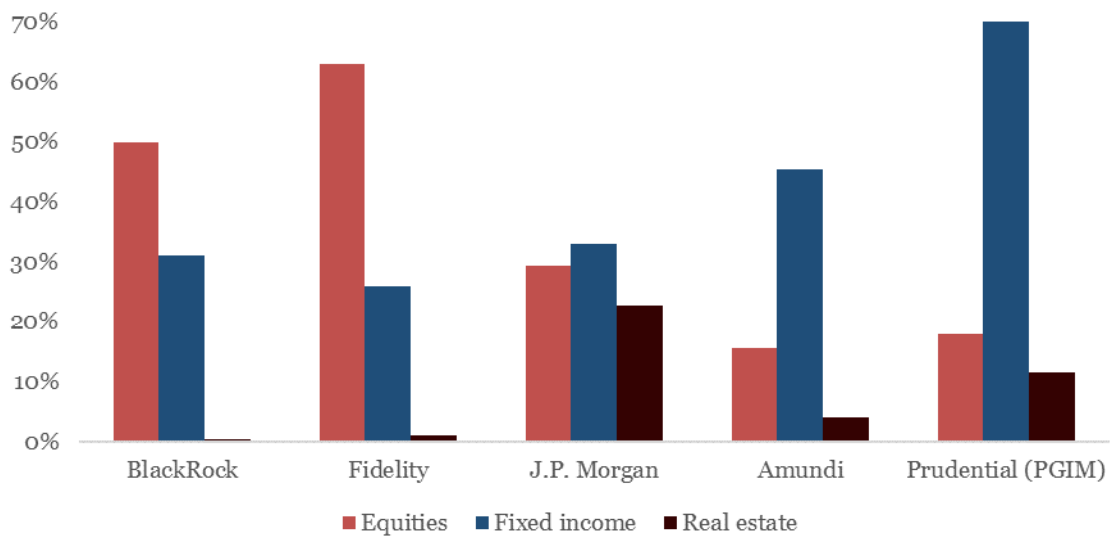
Previous analysis of investment managers has found that typical pension funds allocate 6% of their portfolio to real estate, while typical hedge funds allocate 3.5% (Andonov, Eichholtz, & Kok, 2015). This segment will look deeper into specific investment managers.

The largest portfolio managers in the world are the major American plus some European investment management companies. The largest of these companies: BlackRock Inc., Vanguard Group Inc., and State Street Global Advisors all have more than 2.5 trillion USD in assets under management (P&I, 2020). For many of these managers, it is difficult to obtain an overview of the portfolio weight of REITs and other public real estate, as they are sorted under "equities" together with other stocks in their databases. Looking at the private markets, most of the largest asset managers own little to no direct real estate. Out of the three largest asset managers, only BlackRock reported any real estate, a mere 0.50% of its assets under management (AuM). Most of these asset managers undoubtedly hold some real estate; the exact numbers are just difficult to access due to their reporting practices.

Because of this issue, this paragraph chooses to focus on the major asset managers who directly report their investments in listed real estate: BlackRock, JPMorgan Asset Management, Amundi Asset Management, and Prudential Financial. JPMorgan Asset Management is the seventh-largest asset manager in the world with 1.7 trillion USD in AuM. Among the top 10 investors, it is the manager with by far the biggest allocation to REITs, having 378 billion dollars invested in real estate, corresponding to 22.8% of

all its assets. 4% of its portfolio is invested in unlisted real estate and 18.8% is listed real estate. While JPM invested mainly in listed real estate, U.S Life insurance company, and the world's 10th largest asset manager, Prudential, focused more on unlisted real estate. Prudential was the world's second-largest owner of unlisted real estate in 2018, with 129bn USD invested in the sector (Institutional Real Estate, Inc., 2018). It also had a substantial allocation of 47bn in listed real estate. This amounted to 8.1% and 3.4% of total AuM respectively. French asset manager Amundi controls 1.6bn USD, out of which 1.8% is reported to be unlisted real estate, and 2.2% is listed real estate (P&I, 2020). This provides three different real estate strategies and proves that the major asset managers are not uniform in their investments. Total equity, bond, and real estate portfolio weights can be found in figure eight.

Figure 8: Selected investment managers' asset allocation



Source: (P&I, 2020), (O'Dea & Lowe, 2018)

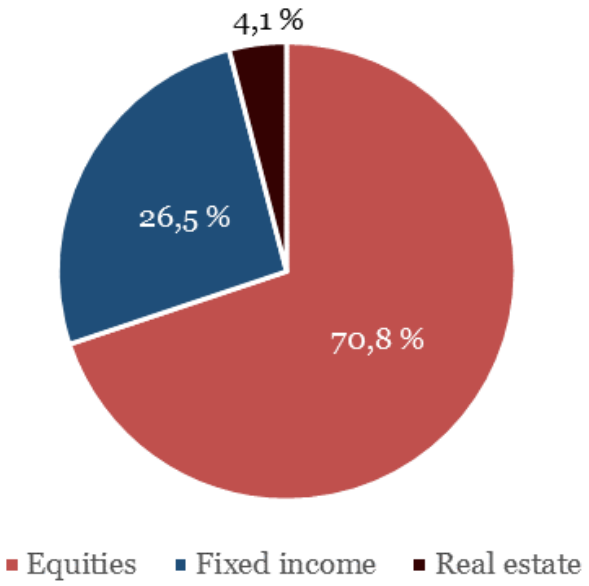
Considering pension funds' and life insurers' missions, it is no surprise they have preferred higher allocations of real estate. These companies are obligated to pay out pensions and/or life-insurance payouts with a specified rate of return, at a predictable time in the future. The safest way to ensure having the liquidity to meet these expenses is to generate a long term cash flow on the received premiums matching the rate of return they have promised their customers. Thus, the fixed cash flows with long contracts received from direct commercial real estate, as well as bonds, seems to be perfect for this kind of investor. The long investment horizons of these investors also make the illiquidity risk of direct real estate, discussed in the previous segment, less of

an issue. additionally, they would want to minimize market risk. The combination of these two preferences could explain why this class of investors tend to prefer direct real estate above REITs. Direct real estate's aptness for this purpose is underbuilt by the fact that there are three insurance companies: Prudential (PGIM), AXA investment managers, and SwissLife among the biggest ten holders of direct real estate in the world (Institutional Real Estate, Inc., 2018).

5.1.2.2 Sovereign Wealth Funds

Sovereign wealth funds (SWFs) are some of the largest single funds in the world. By the end of 2018, the 35 biggest SWFs controlled around seven trillion USD in assets (Kozlowski, 2020). Large resources are used to find optimal strategies for these funds. Thus, it is relevant to analyze their asset allocation. In recent years, most SWFs have gradually changed their portfolios to be more in line with the strategies of the global asset management industry (Hentov & Petrov, 2020). The specific portfolios are difficult to find, as many SWFs lack transparency. Nevertheless, the biggest SWF, Norway's Government Pension Fund Global, managed by Norges Bank Investment Management (NBIM) offers full transparency of its portfolio. At the end of 2019, NBIM's fund had a total AuM of 1.1 trillion USD. The fund's real estate portfolio was worth 47bn USD, about 4.4% of total AuM. Out of the fund's total real estate investments, 66% was in unlisted assets, and 34% was in listed assets, mostly REITs. Hence, real estate is a relatively small part of the fund. NBIM has a mandate to invest up to 7% of AuM in unlisted real estate, and have no restriction on listed real estate investments. Of the real estate investments, the U.S. is by far the biggest market, amounting to ~50% of the fund's real estate values (NBIM, 2020).

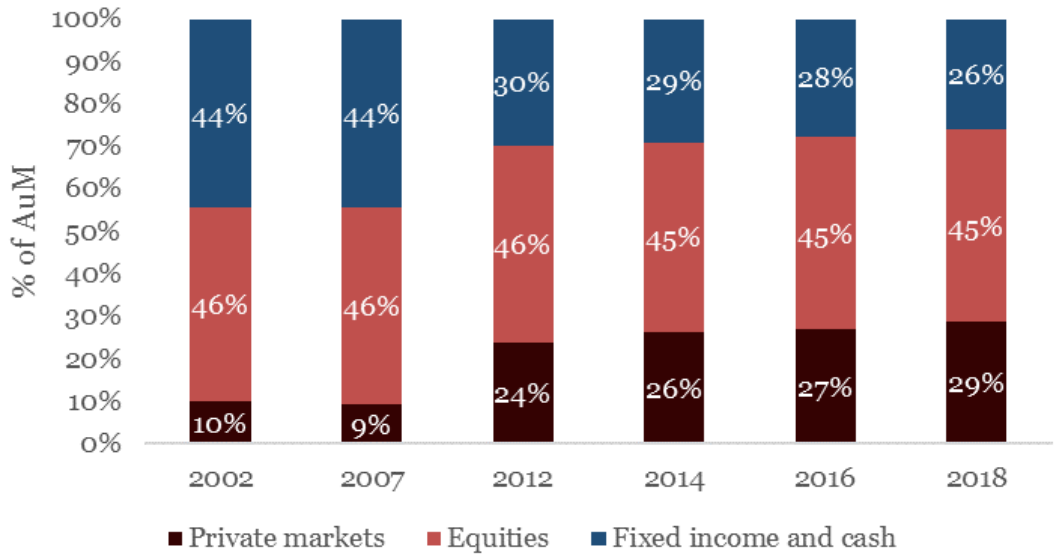
Figure 9: NBIM asset allocation



Source: (NBIM, 2020)

For the remaining SWEs, we have to rely on statistics on a more general level by analyzing how much the funds have allocated to the different markets: Equities, fixed income, and private markets. For these three categories, Elliot Hentov and Alexander Petrov in State Street Global Advisors have published statistics covering the largest 35 SWFs (Hentov & Petrov, 2020). As seen in figure 10, The SWFs have a virtually constant part of their assets invested in listed equities, with the AuM share only fluctuating between 45% and 46% between 2002 and 2018. This part also includes listed REITs, as these are not uniquely identifiable in the reporting for most SWFs. The bigger changes in the portfolios over time have been that considerable funds have been moved from fixed income (corporate bonds and treasuries) to the private markets. These private market investments are mainly private equity, direct infrastructure, and unlisted real estate in the form of direct investments, unlisted REITs, and CREFs.

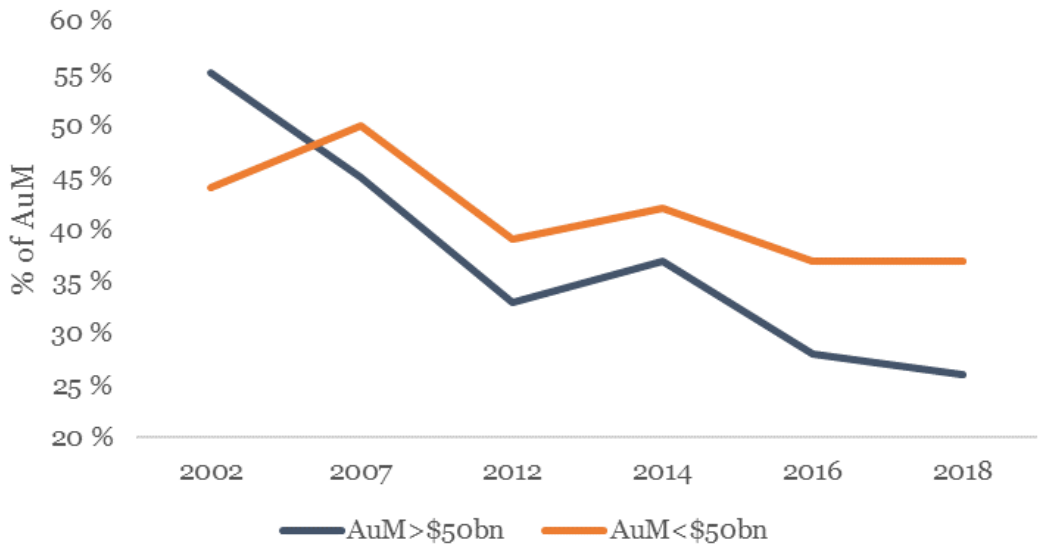
Figure 10: Average asset allocation for SWFs



Source: (Hentov & Petrov 2020)

When dividing SWFs into small-cap and large-cap (smaller and bigger than 50bn USD AuM) as seen in figure 11, it is clear that the large funds have caused most of the transition. In 2002, the large funds held ~55% bonds, and the "small" held ~45%. By the end of 2018, the large funds had on average more than halved their exposure to 26%. The smaller funds only reduced their bond share with around 10%, down to 37%. The report forecasts that the development from fixed income into private markets will stabilize, but slightly increase in the years to come. This is partly due to the belief that interest rates in the U.S. will stay low. Another reason is the tendency of the bigger funds acting as market leaders, and the smaller funds tend to follow their strategy. Thus, State Street predicts that the smaller SWFs will drift towards the allocation of the bigger, and driving the average bond allocation further down, and the direct real estate further up (Hentov & Petrov, 2020).

Figure 11: Allocation to fixed income over time, by fund size



Source: (Hentov & Petrov 2020)

All the managers considered in this segment should have the same goal: To optimize the risk-adjusted returns of their investors' and shareholders' wealth. With that in mind, asset managers are found to have surprisingly different investment strategies. Especially when it comes to real estate, there does not seem to be a defined industry standard except for the fact that everyone has included some real estate in their portfolios. Leading experts in the same field such as JPMorgan and BlackRock have made fundamentally different decisions in regards to real estate allocations, proving that there is no established optimal strategy. This is a sign that investors should be open to reconsidering their real estate weighting and consider the strategies found in this thesis.

5.1.3 Macroeconomic factors

An important aspect when considering the risk of an asset is how the value of the asset tends to move in relation to changes in the macroeconomic landscape. This segment will discuss how real estate performance is related to the macroeconomic factors interest rates, inflation, and recessions.

5.1.3.1 Interest rates

Interest rates are highly important for real estate. As for any other cash flow producing asset, lower interest rates will result in a higher valuation of the asset. Lower interest rates give a lower cost of capital, which gives a lower discount rate which gives a higher

present value of the free cash flows. Thus, using valuation methods relying on discounted cash flows (DCF-analyses), this connection is evident.

For real estate there is also another dynamic increasing this connection. This too is evident through DCF-analysis. Studies show that the majority of a real estate asset's enterprise value usually lays in the budget period, whereas it lays in the terminal value for most other stocks (Damodaran, 2012). This shows that the bigger part of stock values is the company's growth expectations, while the bigger part of real estate values is the actually contracted cash flows, just like for bonds with coupons. For real estate assets, these cash flows are mostly rent payments from properties. With most property classes, these rents are close to guaranteed through long term contracts. Thus, the rent payments for years to come are determined at the time of the transaction. The yield or capitalization rate of the property is then found as the net rental income divided by the market price of the property. This is exactly the same method as to how the yield of a bond is calculated as the coupons divided by the current bond price. Thus, rent payments from properties strongly resemble coupon payments from bonds. The inverse relationship between yields and price are apparent in both asset classes. The yield spread of a bond or real estate asset is the difference between the yield from real estate and the treasury yield. A higher yield spread makes real estate a more attractive investment.

Just like other equities, most REITs have some leverage on their investments. This amplifies the effect of lower interest rates creating higher REIT returns. Mortgage REITs on the other hand, have opposite exposure. Shifts in interest rates will, after a short delay, result in shifts in mortgage rates. Thus, falling interest rates will have a positive effect on equity REITs but a negative effect on mortgage REITs and vice versa (Ibbotson & Siegel, 1984). The vast majority of REITs mostly hold equity, so REITs returns, just like other equities, mostly have an inverse relationship with interest rates. The mortgage REITs somewhat reduces this effect, to some extent making REIT returns less dependent on interest rates.

5.1.3.2 Inflation

Regardless of the asset class, higher inflation results in lower real returns. This means a hike in inflations will cause lower bond prices and lower valuation of equities. Rationally, all cash flow producing assets should be negatively impacted by a hike in inflation and vice versa. Real estate however, has for a long time been considered an

inflation hedge. The notion is that property values and rents typically increase during times of inflation.

Professor William Wheaton at the Massachusetts Institute of Technology (MIT) has researched this field, and analyzed different real estate sectors' effectiveness as inflation hedges over time. The study analyzes national U.S. data from NCREIF for each of the property types: Office, apartments, retail, and industrial. From this data, a "property value" series and a "net income" series have been calculated quarterly from 1978 through 2016. The income and value of the four segments have then been compared to the U.S. cumulative CPI index. Elasticities between the CPI index and value and income respectively, have been estimated with an error correction model, and the results are clear: Some subsectors of commercial real estate have consistently worked as an inflation hedge over the last 40 years. All elasticities were positive, meaning that for all of the four sectors the study analyzed, a positive change in CPI resulted in a positive change in both rental income and value. Focusing on rental income, retail proved to be the best hedge, with income rising a little more than one percent when CPI rise one percent. Income from industrial properties and apartments have provided a partial hedge for inflation. Office income, which was the worst of the four, provided practically no hedge. Even so, the segment provided a slightly positive response of 0.18% rise in income from a 1% increase in CPI. Keeping in mind that the general stock and bond market has a negative elasticity, this is still a decent result (Wheaton, 2017).

Figure 12: Real Estate CPI elasticities

Property type	Income	Value
Retail	1,02	1,07
Industrial	0,7	0,91
Apartment	0,56	0,98
Office	0,18	0,74

Source: (Wheaton, 2017)

The research shows that the elasticity for property values has a stronger connection to inflation than the elasticity for rents. Considering the historical development in property values, these have worked better than income from a CPI-hedge perspective. both retail and apartments are complete inflation hedges. Industrial properties were only marginally behind and have virtually worked as a complete hedge. Even office

property, whose income did not provide much of a hedge, had a solid elasticity of 0.74, meaning office property too, has been a decent inflation hedge in the past.

The reason for the difference in income and value responses, according to Wheaton, is the secular trend downwards in cap rates (yields) for commercial real estate over the last 30 years. The decline in cap rates has almost matched the decline in government interest rates, both in real and nominal terms. In this decline, property values have kept up with inflation even though a significant part of the income has not (Wheaton, 2017).

There is of course no guarantee this dynamic will stay as strong in the future. Retail is extra uncertain, as the sector is experiencing some issues with e-commerce stealing market shares. For most commercial real estate however, rents are adjusted annually for changes in the consumer price index (CPI-adjusted), and residential property rents are usually adjusted annually to the market price, including change in CPI. In total, the notion that real estate works as an inflation hedge is confirmed with historic data, and it seems plausible this will continue in the future, at least to a certain degree.

5.1.3.3 Recession

In the U.S., a recession is defined as "a significant decline in economic activity spread across the economy, lasting more than a few months, normally visible in real GDP, real income, employment, industrial production, and wholesale-retail sales ". It follows from the definition that most industries will suffer from this, and real estate has historically not been an exception. It has however tended to affect different subsectors with different severity.

Lodging and retail tend to move in line with, or even more than the rest of the economy. As people are more concerned about their financial situation and job security, they will spend less on consumer goods and travel. Especially the luxury goods and high-end hotels can be one of the earlier to suffer in a recession. Office, industry, healthcare, and other segments that have professional renters tend to be somewhat more robust. For a business to move location is an expensive and time-consuming process and something that is avoided at most costs. Still, pressure on the market can result in lower rents which leads to lower earnings from the segment. If the situation gets severe enough, companies will default or be forced to move, at which point real estate owners will be in bigger trouble.

Residential real estate tends to be even more robust. High unemployment will put a strain on personal economies. Still, welfare systems tend to keep most people from having to move out of their homes. In the long term, rents will go down and so will property values, but a collapse in the residential markets will take a long-lasting crisis, or uncontrolled use of leverage like seen in the 2007 crisis. The market is now more regulated and controlled, making a large-scale bust in the residential real estate market less likely.

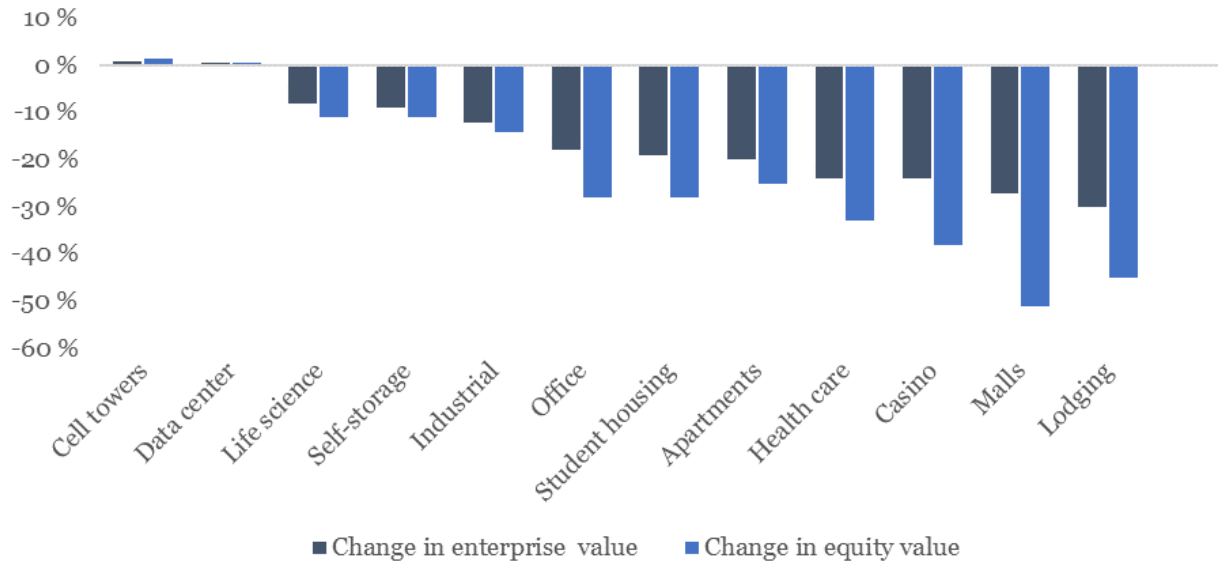
In total, fluctuations in real estate value seem to be less directly linked to macroeconomic shifts than stocks. All real estate is in some way dependent on leases and customers, and even though real estate is a core asset and the assets themselves will not change by a recession, the change in companies' and people's economy and liquidity tend to slow down the demand for properties, eventually driving property values and rents levels down. This analysis will continue in the next chapter, where the COVID-19 crisis provides a specific example of a recession.

5.1.4 The COVID-19 crisis

After 2008, the stock market and real estate market both experienced a more or less uninterrupted bull market of 11 years. During the creation of this thesis, the bull market came to a sudden end, when the U.S. stock market shifted downwards in the last week of February 2020. The COVID-19 crisis has now critically impacted our society and the international economy. In absolute terms, the USA has been hit the hardest by the virus as of mid-April 2020, with the most confirmed cases and the most deaths from the virus (Johns Hopkins University & Medicine, 2020). This has led the U.S. to the brink of a recession. In late March 2020, Congress passed the CARES Act, providing stimulus packages to support directly and indirectly all sectors of the economy. The CARES Act is unprecedented in size, injecting 2.1 trillion dollars into the economy. Still, big consequences for the economy and financial markets seem unavoidable. The ultimate severity of the impact is still unknown, with different experts providing varying outlooks. Most experts seem to agree that the impact will differ greatly between industries, and also amid the real estate sector. This chapter's objective is to provide clarity amongst the many deviating views and the general chaotic situation by presenting an overview of and discussing different scenarios.

As of May 2020, it is evident that some parts of the real estate sector are highly affected by the crisis. The geographic location of assets is of course a highly significant factor, as some cities are far more impacted by the crisis than others. This will not be analyzed further, as the more or less impacted cities can change quickly, and a geographical analysis has less relevance for the research question. It is more relevant to analyze the different real estate segments' reactions to the crisis. As seen in figure 13, property segments with greater human density have been hit the hardest: regional malls, lodging, healthcare facilities (except hospitals), and student housing have seen a drastic decrease in operating income (Gujarl, Palter, Sanghvi, & Vickery, 2020). The following paragraphs will take a deeper look at some core real estate segments that have experienced more or less of an impact.

Figure 13: Change in U.S. unlevered and levered value from Feb 21st to Apr 12th



Source: (Lachance & Tibone, 2020)

5.1.4.1 Lodging

One of the first sectors to suffer from COVID-19 was the hotel industry. On March 14th, the U.S. closed its borders towards the outside world. This set an immediate stop for international tourism and business travels alike. Already at this point, the hotels were suffering greatly. Then, on March 19, the state department issued a "do not travel" advisory, robbing hotels of their domestic customers too. These new rules in combination with the general fear of going out among people are all factors that have made many hotels close their doors temporarily and even go bankrupt. As of April 3rd 2020, Green Street Advisors estimates the unlevered enterprise property value of American lodging assets has already declined by 37%. This makes lodging the undisputed loser among the real estate sectors in the COVID-19 crisis (V. Gujarl et al., 2020).

Marriott Hotels, the largest hotel operator in the world in terms of hotel rooms and total revenue, reported numerous shutdowns. Approximately 25% of Marriott's 7,300 hotels worldwide are temporarily closed. In the U.S., 870 Marriott hotels have temporarily shut its doors, amounting to 16% of all its U.S. locations (Oliver, 2020). 16% might not seem that extreme, but the hotels that are still open are facing drastically fewer guests, lower daily rates, and lower revenues.

Hospitality analyst company STR analyzes the U.S. hotel market on a continuous basis. Its report of week 15 (April 6-12th) shows that compared to the same week in 2019, average occupancy was down 69.8% to an unprecedented 21%. This means that approximately 79% of all hotel rooms in America were empty. In STR's data going back to 1987, the previous worst occupancy level was 54.6% during the financial crisis in 2009 (STR & Tourism Economics, 2020). Naturally, this low occupancy also resulted in lower room prices, with average daily rates (ADR) down 45.6% year over year, averaging a nightly rate of 71 dollars. These two factors combined result in a terrible outcome for the most common hotel valuation metric: revenue per available room (RevPAR). RevPAR was, on average, down 84% compared to week 15, 2019. For week 18 (the week ending May 2nd), occupancy, prices, and RevPar were up around five percent compared to week 15 (STR, 2020). This indicates that these staggeringly low hotel earnings have become the new normal during the crisis, and will probably stay about as bad for as long as there are travel restrictions (STR, 2020).

The big hotel brands such as Marriott and Hilton mostly do not own their hotels; they operate them and rent the properties from an investor, typically a REIT. As opposed to most residential and office properties, where rent is paid as a fixed amount, hotels normally pay a variable rent. In short, if a hotel does well, they will pay the REIT more rent, and if it does poorly, it will pay less rent. This makes hotel owners more directly connected with the tenants' struggles than the owners of many other real estate sections, further worsening the situation for hotel owners.

5.1.4.2 Retail

Retail has been a struggling segment long before the coronavirus hit the market. Department stores have closed down locations and independent stores have gone bankrupt. This already stressed segment is now being severely tested, as government-imposed social distancing is forcing stores to close down. Real estate owners are experiencing permanent loss of cash flows from retail tenants and an elevated chance of bankruptcies, despite government support.

From the crisis began in late February until April 15th, the share prices of publicly traded retail REITs have declined by 45% in the U.S. and 43% in Europe. The effect is so bad that retail owners most likely are seeing a worse situation now than during the 2008 crisis (Lachance & Tibone, 2020).

5.1.4.3 Office

In the Nordic region, more office deals were executed in Q1 2020 than in Q1 2019. From the statistics, it looks like the market is as liquid as before. An issue is that the deals that were signed and executed in March 2020 counts towards this statistic. Large office deals usually take months to negotiate, so the deals that were publicly announced at the beginning of the COVID-19 crisis were essentially agreed upon before the crisis hit Europe and the U.S. (Bjølgerud, 2020). This example is based on Nordic data because a general U.S. statistic was not found regarding office transactions. The notion of a delayed effect on transactions however is also true in the U.S., as the transactions here are even more complex.

Like most other stocks, office REITs have taken a beating. Considering the three largest office REITs in the Nareit index: Boston properties Inc. and Kilroy Realty corporation are down about 40% since the end of February, as of May 11th. The second-largest REIT, Alexandria Real Estate Equities, was also down almost 30 percent, but

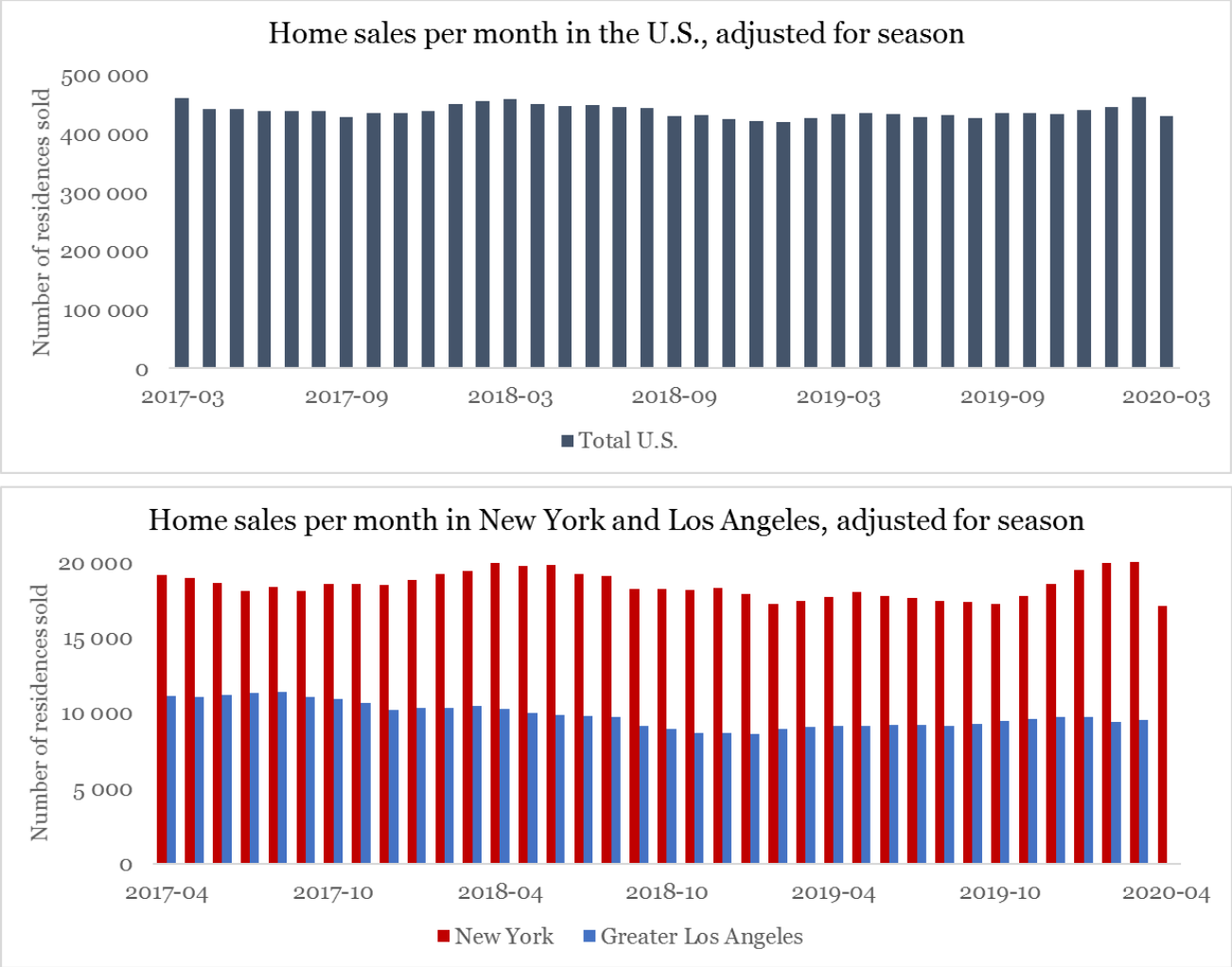
the stock turned march 23rd and is now almost back at the same level as at the end of February (Yahoo Finance, 2020d). One explanation for this could be that the office REITs fell because the entire market was plunging, not because the crisis was bad for office properties. In that case, the office REITs fell more than the asset values of the buildings in the REITs. As discussed in the *REITs VS direct real estate investments* paragraph, REITs have a higher correlation with the general stock market than the real property value for short investment horizons, especially during crises. Thus, in a crisis, REITs are typically not priced in line with their underlying real estate value (CBRE, 2020). This indicates that the large loss in office REITs could be an overreaction, that the office prices will stabilize, and that property prices will not go as low as the REIT prices indicate. Nevertheless, it is too early in the crisis to make conclusions, and office prices, both direct and REITs could still go even lower.

5.1.4.4 Residential

As discussed under the recession paragraph, residential real estate typically sees a delayed effect from economic crises. In this crisis, people are advised to stay inside their homes unless absolutely necessary. This is one of the reasons people are not going house-hunting. They simply are following government advice and also do not want to contaminate themselves with the virus. In addition to this, with businesses struggling and more people than ever before in American history are getting laid off their jobs, these are uncertain economic times for most Americans. One would believe that people who fear for their financial future inherently do not want to do big investments like buying a home or sign a new lease on an apartment. Because of this, the development in the number of transactions in the housing market is analyzed.

The complete output of sales data for the U.S. and its two largest cities is found in figure 14 below. The numbers are adjusted for variations in seasons, as transactions and prices usually are higher in the spring, and lower in the fall and winter (Zillow, 2020). The adjustment is minimal but still makes it easier to separate between normal seasonal differences and market trends.

Figure 14: Home sales per month



Source: (Zillow, 2020)

February

As figure 14 shows, sales rose from January to February across the U.S, including New York, the city hardest hit by the coronavirus. This indicates no immediate effect on the housing market. In Los Angeles, the U.S. second largest metropolitan area, and with the second-most cases of the virus, the number of transactions fell with 3% from January to February, indicating a slight effect.

March

In March, the situation gets more interesting, as the U.S total sales numbers were down 6.8% since February. Considering how stable this metric has been historically,

this is a significant drop. Still, month over month sales has dropped more on several occasions over the last decade, last time in 2017, so the reaction is not considered overly extreme (Zillow, 2020).

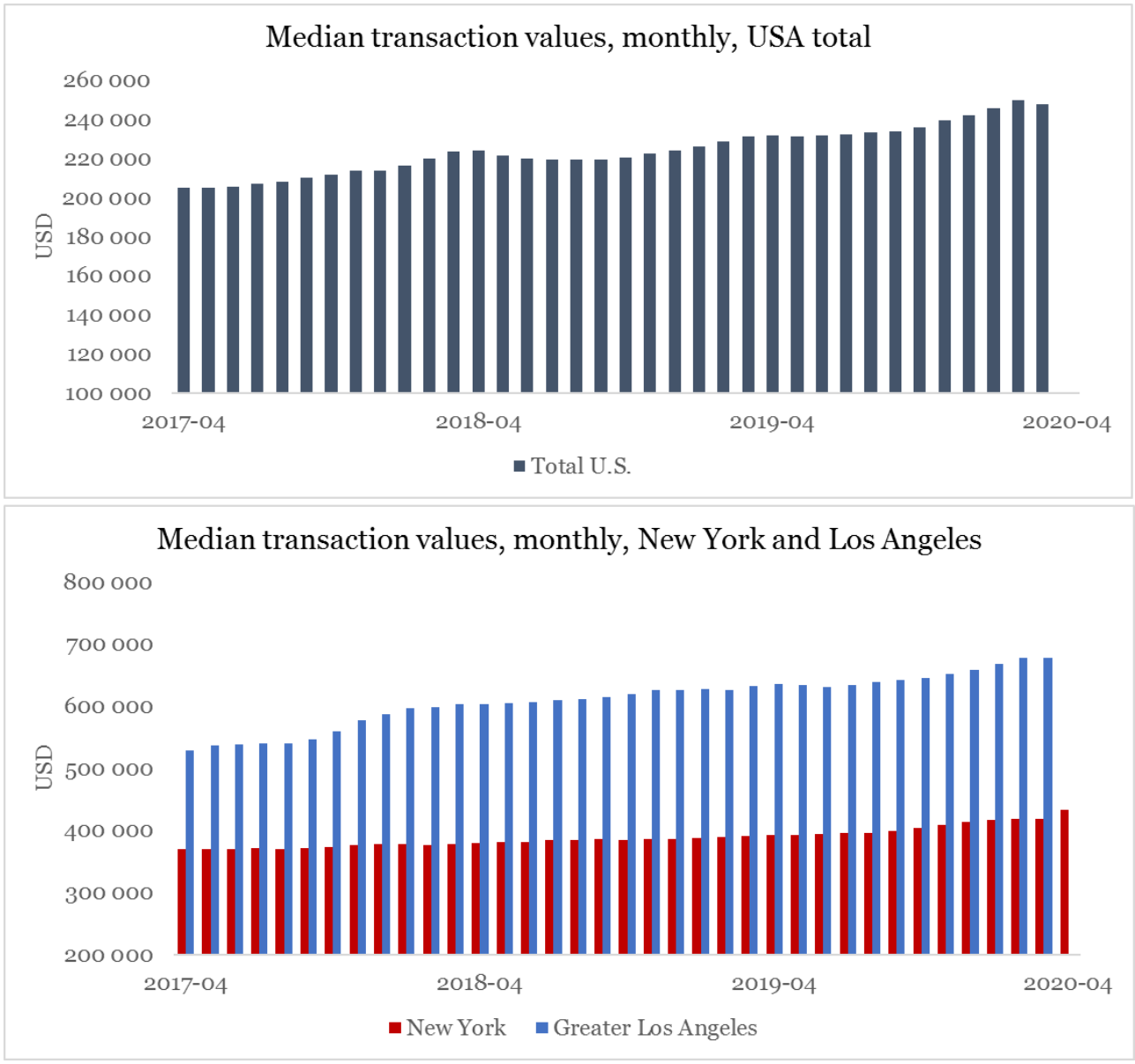
Surprisingly, New York's sales are still up from February to March, despite the pandemic worsening rapidly in the area. The same is the case in Los Angeles, where sales numbers were up from February to March, but are still lower in March than in January.

April

As of May 10th, most cities, Los Angeles included, have not updated their statistics for April. Because of this, the total U.S. metric is also unavailable for April. New York has published April numbers, showing the number of transactions fell with 15% from March to April. This is the City's biggest month over month drop in sales in Zillow's 10-year database history (Zillow, 2020). New York's drop confirms that areas directly affected by the virus will suffer a serious cool-down of the housing market. In the lack of national data, the next cities on the list are examined. Among the 100 biggest U.S. cities, 20 of them have updated April sales numbers. All of these 20 cities had significantly fewer transactions in April than March. The city whose sales were down the least was Denver, Colorado, with a -6% change in sales. The city where sales were down the most was Springfield, Massachusetts, with a -19% change in sales. The average of the 20 cities was a decrease of 11,5% from March to April. The average drop in sales from January to April was 5.9%. This shows that even urban areas with the virus more contained see transactions drop significantly. Even though this is only a sample of the U.S. housing market, the numbers all point in the same direction, and is a clear indication that the whole country's housing market is affected.

Zillow also provides data on the transaction prices of all the properties in the "home sales per month" statistic. The development in monthly median prices, seen in figure 15, shows that the coronavirus has not made a statistically visible impact on home prices as of the end of April. Numbers from both U.S. total, New York, and greater Los Angeles show that the median sale prices in March were higher than in February and January. New York prices were only marginally higher in February than January, but this cannot be regarded as an anomaly in a market where growth has been minimal over the last three years.

Figure 15: Median transaction values, all homes



Source: (Zillow, 2020)

Just as for the sales count, April numbers for U.S. total and the majority of U.S. cities were not available by mid-May. The development of sales-prices in April is therefore analyzed through the 20 out of the top 100 U.S. urban areas that have released their data.

The transaction prices tell a different story than the sales numbers. In April, New York alone had more cases of COVID-19 than any other country in the world (Johns Hopkins University & Medicine, 2020). Still, median sales prices were up 3.5% from March to April. Among the twenty cities investigated, five saw a decrease in median

sales price from March to April. None of these five cities were among the biggest 50. Only one city, Des Moines, Iowa, had lower median sales prices in April than in January. In total over the 20 cities, median sales prices were 1.8% higher in April than in March, and 3.2% higher in April than in January (Zillow, 2020). As for the sales count analysis, this is based on a sample of urban areas, but the data is also here pointing in the same direction: As of April 2020, the crisis cannot be said to have made a significant impact on the U.S. housing prices.

The key takeaway from the housing market is that the impact was not immediate, but that it has slowly affected the residential market. Transaction volumes are significantly down in April, and will likely continue down in May. Sales are down regardless of geographic location, with effects seen in areas with and without a large presence of the virus.

Even though fewer properties are changing hands, the transaction values are not affected. There can be several reasons for this, but one likely factor is that the transactions we see in March and even April could have been more or less agreed upon before, or at the beginning of the crisis. To buy and sell a house is as earlier mentioned a large and time-consuming process, which will cause some delay between a shock hitting the market, and that shock affecting the prices. In Norway, a country where the virus spread earlier than the U.S., housing prices were affected negatively already in March, falling 1.4% (DNB Markets, 2020). Despite most experts predicting Norway's prices to fall even more in April, the seasonally adjusted prices were down only 0.2% over the month (Eiendom Norge, 2020). COVID-19 has impacted the U.S. significantly worse than Norway, so if Norway can be used as an indication for the U.S., the American housing prices should also go down a few percent, and this will likely happen soon.

5.1.4.5 Forecasts for the rest of the crisis

How the crisis will continue to affect the market is difficult to forecast. The COVID-19 crisis is unprecedented in our modern economy, and it is unknown for how long it will last, and how bad it will get. The forecasts of the general economy should, however, be a useful indicator.

The economic downturn experienced in the last two weeks of March were enough to offset the growth of Q1 2020, bringing the U.S. GDP growth of Q1 to approximately 0%. Considering the expectations of the most prominent American experts and investment banks, the crisis will continue in Q2, and result in severe losses for the U.S. economy. As seen in figure 16, the GDP expectations were highly divergent, the most optimistic being -9%, and the most pessimistic -50% annualized compared to Q1 (Charles Schwab, 2020). This large spread itself is highly unusual, with experts normally having more or less the same forecast, usually only a few percent apart. The current large spread illustrates the uncertainty of the situation. All these institutions have experts making forecasts, and when they come up with such different answers, it proves that nobody knows what will happen, even just two months into the future. It seems the only thing experts agree on, is that the U.S. real GDP will continue to drop over 2Q. The average expected drop is almost 30% in one quarter. This will by far be the largest quarterly GDP drop in U.S. history, as the largest quarterly GDP drop so far was 10% in 1958. Back then, some 2 million people lost their jobs. So far, the corona crisis has resulted in over 16 million new jobless claims as of April 10th 2020. JPMorgan forecasts unemployment to hit 20% in 2Q (Klebnikov, 2020). Regardless of which analyst is right, it seems inevitable that a downturn of this magnitude will shake more or less the whole economy.

Figure 16: Institutions' GDP forecasts for 2Q, made at the beginning of Q2

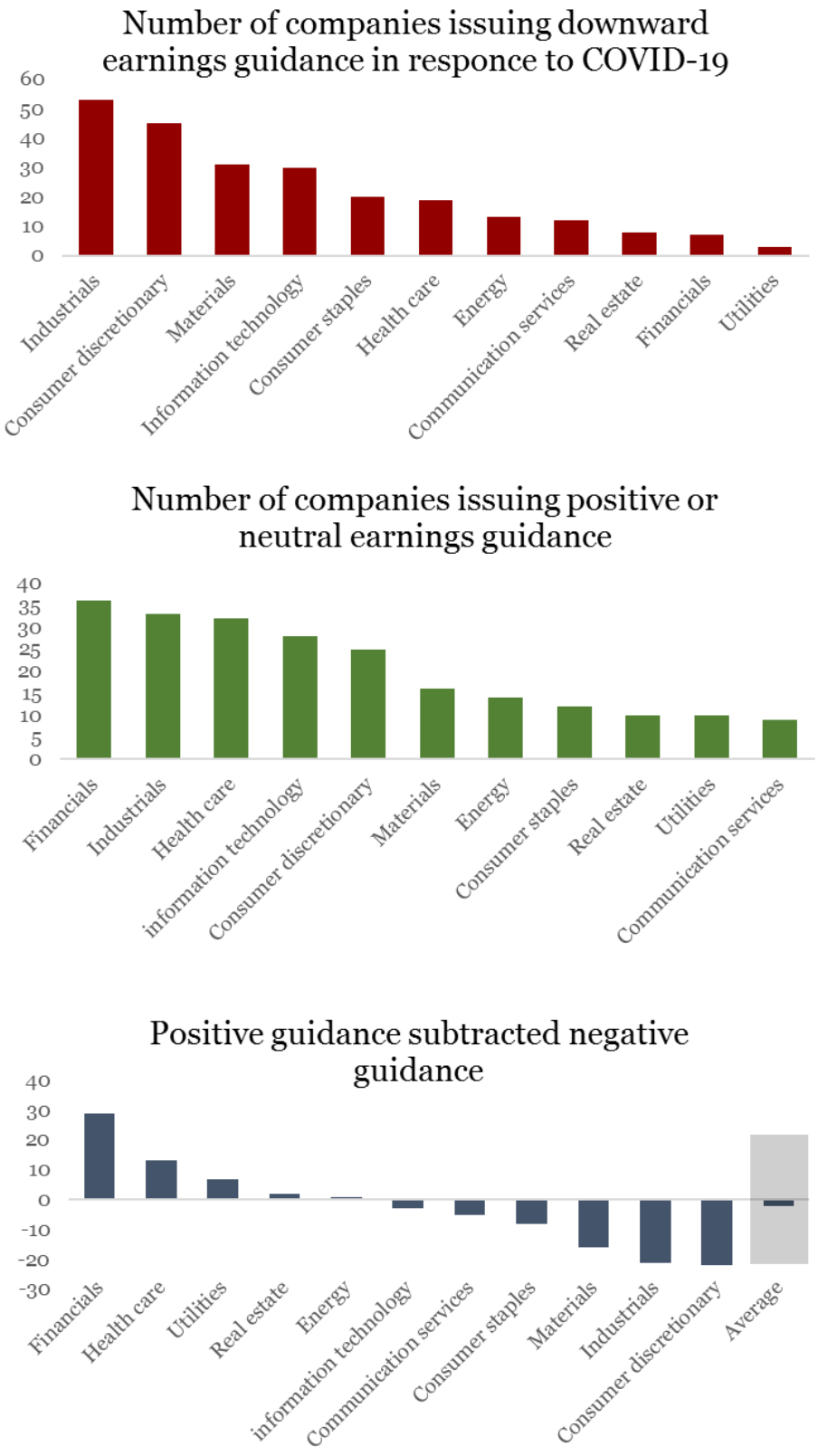
2Q real GDP forecasts (Q/Q)	
Firm	**2Q 2020 GDP estimates**
Bloomberg Economics	-9,0 %
TSLombard	-17,7 %
Wells Fargo	-22,3 %
Cornerstone Macro	-25,0 %
JP Morgan	-25,0 %
UBS	-25,0 %
IHS Economics	-26,5 %
Bank of America Merrill Lynch	-30,0 %
Oxford Economics	-32,0 %
Deutsche Bank	-33,0 %
Strategas	-33,3 %
Credit Suisse	-33,5 %
Goldman Sachs	-34,0 %
Barclays	-35,0 %
Morgan Stanley	-37,9 %
Capital Economics	-40,0 %
Evercore ISI	-50,0 %
Average	**-29,95 %**

Source: (Charles Schwab, 2020)

Focusing on the specific business sectors, it is interesting to see what the businesses are expecting themselves. Figure 17 shows an overview of companies' earnings guidance in response to COVID-19, given fairly early in the crisis, 03/06/2020, sorted by sector. All companies in the survey are MSCI world index constituents. The figure represents the numbers in absolute companies, not the percentage of the sector. Thus, the negative responses need to be compared to the positive responses to get a good foundation for comparison.

It is important to emphasize that earnings guidances are reported by the companies themselves, and thus may contain a positive bias. This could be an explanation as to why the total (average) expectation from the businesses themselves are far less negative than the GDP forecasts made by less partial analysts. Still, it is evident that some industries stick out as more optimistic, some more pessimistic, and some disagreeing within the sector. Health care and financials are the two most consistently optimistic industries. The most pessimistic is, perhaps not surprisingly, consumer discretionary (Charles Schwab, 2020).

Figure 17: Overview of companies' earnings guidances as of March 6th



Source: (Charles Schwab, 2020)

Real estate companies are, together with industrials, IT, and energy, among the less unison industries. I.e. the industries where some companies are optimistic and other pessimistic. Among the real estate companies, eight reported negative expectations and 10 reported positive expectations. One reason for this could be the high diversity within the real estate segment. Real estate companies focused on lodging, retail (especially discretionary consumption goods), and industrials, are likely to share the views of the companies in this sector. Real estate companies focusing on segments such as health care, utilities, and office space for financials would likely be more positive. Regardless of that, considering the real estate segment as a whole like this statistic, real estate is one of the few segments that expect COVID-19 to have a neutral or even positive impact on the earnings. It has to be emphasized that without a global pandemic, close to all of the real estate companies would probably issue positive earnings guidance, as that is "business as usual". Thus, these numbers should not be interpreted as COVID-19 being good for the real estate sector. What it shows however, is that the real estate sector, compared to most other sectors, is not expecting the crisis to affect them as severely.

A consequence of the COVID-19 crisis expected to affect all real estate sectors is the lack of liquidity that is caused by the scarcity of capital. Bård Bjølgerud, CEO of Pangea Property Partners, a Nordic commercial real estate brokerage and analysis company, describes the dynamic like this: With many businesses struggling, the banks focus on the clients they already have, and the assets these clients already own. They will give out extensions on loans, accept later payments, and provide other amenities to keep customers' operations afloat and avoid bankruptcies. But, the banks are hesitant to finance investors wanting to expand their portfolios and do investments. As most investors are dependent on some debt financing to afford, or to turn a positive NPV on their real estate investments, this stops many transactions from happening. Lower liquidity in the market results in higher liquidity risk, which in turn lowers the property values. This is a surprising effect, as one would believe that the lower interest rates would make debt financing more accessible and have a positive effect on real estate transactions. The problem however, is not the interest rate. Because of the higher perceived risk in the market, banks are requiring higher margins on loans. The effect is that despite lower borrowing rates, the cost of debt could be unchanged or in

some cases even higher now than before the crisis, and the commercial real estate transaction market is expected to more or less halt completely in Q2 2020. It will take some time to start his market again, so if society does not reopen during Q2 or Q3, 2020 will be considered a lost year when it comes to commercial property transactions (Bjølgerud, 2020).

5.1.4.6 Long term consequences of COVID-19

After the pandemic is over, one has to expect the society and economy to stabilize. However, things will likely not go exactly back to "normal". Experts at CBRE and McKinsey among others, predict that some corona-caused changes in consumer habits and the conduction of business will likely stay, and that the virus will accelerate long-term trends. This paragraph presents some perspectives on potential long term impacts from the COVID-19 crisis.

Residential

The market for residential real estate could see some long-term effects of the pandemic. Trends in where Americans choose to live is a complicated field on its own, and no urban area is the same. But perhaps the most defining long term trend has been that America saw a huge boom in people migrating to the suburbs after WW2. After the 2008 financial crisis, the suburbs have seen a decline in popularity, as millennials have preferred living in urban areas. In the last few years however, there has been a slight shift, as more millennials are moving to the suburbs. The reason is, most likely, that they have reached a new stage in their lives: they are starting families and getting children, which is more convenient and affordable when not living in the downtown of a big city (Adamczyk, 2019).

There are several reasons the COVID-19 virus could contribute to single-family homes in the suburbs increasing more in popularity. The most direct reason is that more people are now are experiencing how unpleasant it is to live through quarantine in a small studio- or one-bedroom apartment. With virtually everything being closed, none of the arguments for living in the big city applies anymore. The dependence on public transport and elevators, and the general crowded nature of city centers, makes it not just less comfortable, but also riskier in terms of contamination. In addition to this, there are a lot fewer supermarkets and grocery stores per person, which made the stores run out of food and toilet paper a lot earlier in the cities than in the suburbs,

when people started to stock up. In the suburbs, single-family homes are more affordable, and if you have to stay inside for weeks or months, a house with a backyard and more rooms to recreate would naturally be preferable. This could not only cause more people to move from the cities to the suburbs, but it could also make the people wanting to move from the suburbs to the city to change their minds. Many "Empty-nesters" i.e. couples whose children have moved out, and are now living in a house much bigger than what they need, have historically sold their big suburban houses and moved to smaller three or four-room apartments in more urban areas. One could imagine many of these families are now reconsidering (Rivera, 2020).

The indirect effect that could accelerate the same trend, is that the crisis is causing people to lose their bonuses, parts of their savings (through bonds and stocks), or even lose their jobs. As living costs in the cities are higher than in most suburbs, the virus could force people out, as they will get more space for the same price, or the same space for less, if they move further out from the city center. Many suburbs also have good public schools, whereas expensive private schools can be the only option for inner-city families with ambitions for their children. In Boston, this effect is already happening, as the suburb houses for sale are now on the market for an average of five days instead of the normal average of 42 days (Rivera, 2020). it seems a likely scenario that suburbs and smaller metropolitan areas will get more popular in the years to come.

Office

Within office real estate, there has over the last decades been a trend towards densification and open landscape based office layouts. Public health officials could decide to increasingly amend building codes to minimize the risk of pandemics in the future. This could affect the standards for square meters per person and the maximum amount of people in an enclosed space (V. Gujarl et al., 2020). If measures like this are taken into action, the trend of increasingly open office plans could slow down, or even reverse back into the old model with more separate offices, and more space between the employees.

Already before the crisis, many large companies had begun to cut down on the number of desks, and are in fact having fewer desks than employees because they know a few percent of the workforce will be sick, have time off, be on business travel, etc. at any

given time. James Gorman, the CEO of the international investment bank Morgan Stanley reflected on this in an interview with Bloomberg Television. The bank has moved approximately 90% of its more than 80,000 employees to work from home during the crisis. Gorman says this transition has been "surprisingly smooth". He said that after life returns to normal, he of course would want most staff to return to the office, but they have proved that the company can operate efficiently with much less real estate. "Can I see a future where part of every week, certainly part of every month, a lot of our employees will work from home? Absolutely" he said (Gorman, 2020). If many companies start to think like this, it would over time result in lower demand for corporate office buildings.

These two effects could to some degree weigh each other out, in that companies will want fewer employees in offices at a time, but these fewer employees might require more space per person. Regardless, the most plausible total effect on the office market seems to be more uncertainty and a negative net effect.

Health Care

The U.S. has a relatively healthy demographic pyramid. However, it does have a slightly aging population, with 12.25% of the U.S. population being between 50 and 70 years old (PopulationPyramid.net, 2020). This demographic, the baby boomers, will over the next years and decades grow into the prime age for independent and assisted living facilities. The large outbreaks of COVID-19 in such facilities have created strong fears as their occupants are among the people taking the most damage from the virus. It is reasonable to think the fear of the assisted living facilities turning into hubs for pandemics, combined with rules against taking visitors from friends and families into, will make these facilities less popular in the years to come. Some elderly people of course may not have any other choice, but for relatively healthy people who are not dependent on assistance, they may want to to stay in their homes longer because of this fear. This fear could again potentially result in the assisted living facilities changing their services, offering more physical space per person, and stricter operational requirements (V. Gujarl et al., 2020).

Lodging

It is possible that the fear of pandemics changes how people do their leisure travels. In the short term, it is plausible that people will avoid traveling overseas, which could

give more domestic visitors to hotels, but at the same time fewer international guests. After a few years however, it is unlikely that a significant amount of people will change their vacation habits because of the fear of a new pandemic.

Business travel could however change more permanently. The dynamic described in the office paragraph, of the surprisingly few negative effects of working from home, could likely affect business travel more than office properties. Sending employees on planes to other cities and have them staying in hotels just to attend a few meetings can be a highly inefficient use of the workforce and company funds. On many occasions, digital meetings solutions are sufficient or even preferable. As companies' workforces are now forced to work from home, more companies are implementing and getting used to having virtual meetings and video conferences. Thus, the corona crisis could help pave the way for virtual meetings replacing a bigger share of business travel. This could lead to great losses for hotels, especially in cities with big business centers, but few tourist attractions, such as Houston, Texas, and Charlotte, North Carolina.

Retail

One of the areas where experts seem to agree the most about the future is retail. For many years now, traditional retailers have been struggling. It is nothing new that e-commerce is taking over market shares from brick and mortar retailers. Still, when people are not able or do not want to leave their homes, it will likely force the many customers still preferring to shop in stores to do it online. Depending on how long this pandemic lasts, it could also force people who have hesitated to try online shopping, the late majority, and laggards, to open up accounts and give internet shopping a try. Many small local retailers are going bankrupt, and big department stores and malls like Macy's and Nordstrom which were already struggling before the crisis are closing down stores and limiting their physical presence. As physical stores are being pushed over the edge by the crisis, the local shopping opportunities for many Americans will be more limited, again contributing to e-commerce's competitive advantage. Through these dynamics, COVID-19 is likely to accelerate the shift towards e-commerce (V. Gujarl et al., 2020).

Industrial

With a change in the retail industry follows a shift in logistics. More goods being sent directly to the end-user instead of retailers make the logistic more complicated, as the

transportation chains are being disrupted. In short, consumers demanding more deliveries at higher speeds make logistics more important. Already in 2016, a study conducted by Cushman & Wakefield found that industrial vacancies were at a 15-year low. The reason for this, they concluded, was the need for industrial properties for large logistic halls, processing centers, and last-mile distribution centers (Selko, 2016). Industrial real estate, including logistics, has already been among the best performing real estate sectors over the last 20 years, and with this trend, it is expected to continue.

Other big potential industry shifts caused by the crisis are on-shoring and near-shoring. Businesses see that it is risky to have production, storage, and other parts of the value chain abroad, or generally far away from the end-user, when transport is stopped and trade is halted. This could drive more American industries to move larger parts of their value chains back to the U.S., and perhaps closer to the urban areas. A hike in domestic production would not only be good for the industrial property market; it would also increase logistics and warehouse demand (CBRE, 2020).

5.2 Quantitative analysis

The quantitative analysis consists of independent analysis based on raw data from different indexes and assets. This sector is divided into two subsectors: the All REIT Index, analyzing the REIT segment as a whole, and the sector analysis, going a little deeper and analyzing the REIT segments separately. The historical returns and risks of the different asset classes and sub-sectors are presented and evaluated, and this historical data is then used to create optimal mixed-asset portfolios.

5.2.1 All REIT Index

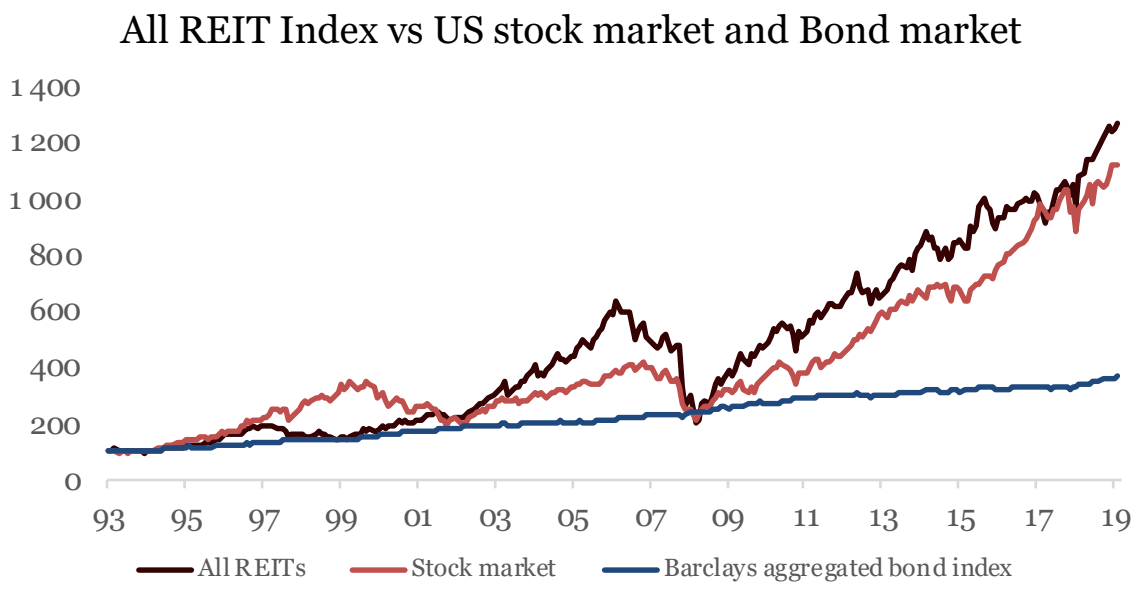
The FTSE Nareit All REITs Index represents the majority of the U.S REIT market and serves well as a benchmark for REIT investments. Focusing on REITs as a whole, this segment will analyze the returns and volatility of the U.S REIT market, and compare REITs to other financial assets. MPT theory will be used to construct mixed-asset portfolios, and find optimal weights of REITs for a mean-variance investor.

5.2.1.1 Return

By looking at the indexes for REIT, Stock and Bond return in figure 18, it is immediately evident that there is a correlation between REITs and the stock market. Since January 1994, both the REITs and the stock market have grown considerably.

The stock market started stronger in the late 90s, mainly due to the IT-boom. This bubble busted in 2000, and the three asset classes were back at the same level in late 2001. From 2002, the REITs increased significantly more than stocks and bonds as financing and mortgages were cheap and the real estate market was booming until 2007. The 2007-2008 global financial crisis hit the real estate market extra hard, bringing the REITs back down to the same level as the stock market and bond market. Since 2009 there has been a long bull market for both stocks and REITs. At the same time, bond yields have gradually decreased, resulting in lower returns from bonds. This has resulted in stocks and REIT investments growing a lot more than bond investments. By the end of 2017, the REIT and stock market returns were exactly the same, but the REITs experienced slightly higher growth in 2018 and 2019.

Figure 18: All REIT Index vs U.S. stock market and bond market. Dec 1993- Jan 2020



Source: (Nareit, 2020c), (French, 2020), (Yahoo Finance, 2020)

In total, the average yearly return of the ALL REIT index was 12.04% between 01/01/1994 and 01/01/2020. In the same period, the average yearly return of the stock market was 10.99%, and the bond market 5.18%. The worst five-year period for REITs was 1994-1999, with average annual returns of 7.27%, followed by 2005-2012 when annual returns were 7.51% on average. For stocks, the worst five-year periods were 2000-2005 with only 0.68%, and 2005-2010 with a 4.80% average annual return. For

the bond market, the two worst periods were notably 2016-2020 with 3.12% and 2011-2015 3.84% average annual return. Diminishing bond yields over the last ten years have made bonds less attractive, as illustrated by the steadily sinking development of the ten-year U.S treasury yield from 1993 to 2020 in figure 19.

As for the best performing periods, this was 2000-2005 and 2011-2015 for REITs, with 21.20% and 12.74% average annual return respectively. For the stock market it was 1994-1999 and 2016-2020 with average annual returns of 23.71% and 13.89% return. Bonds did best from 2000-2005 and 1994-1999 with 6.45% and 6.05% return. The complete overview of returns over the five-year periods can be found in appendix 7.1.

Figure 19: 10y U.S. treasury yield

Source: (Yahoo Finance, 2020c)

5.2.1.2 Volatility

Volatility measures the movement in value of an asset in both directions, and thus it is a representation of the dispersion of an investment. Volatility is the core of the most common risk measurements for financial assets, making volatility as significant to analyze as returns.

Historical volatility, also known as statistical volatility, is calculated from the fluctuations of historical asset prices. The formula for sample variance is used, as the monthly adjusted prices used in the data set do not contain all the data points in the

population. The sample variance uses "n-1" instead of "n" in the denominator, creating an unbiased estimate with a slightly higher variance compensating for the uncertainty from not having all the data points. The sample variance is given by the formula:

$$\sigma^2 = \frac{\sum_{t=1}^{n}(x_i - \bar{x})^2}{n-1}$$

Where:

$\sigma^2 =$ sample variance

$x_i = Value\ of\ i^{th}$ data point

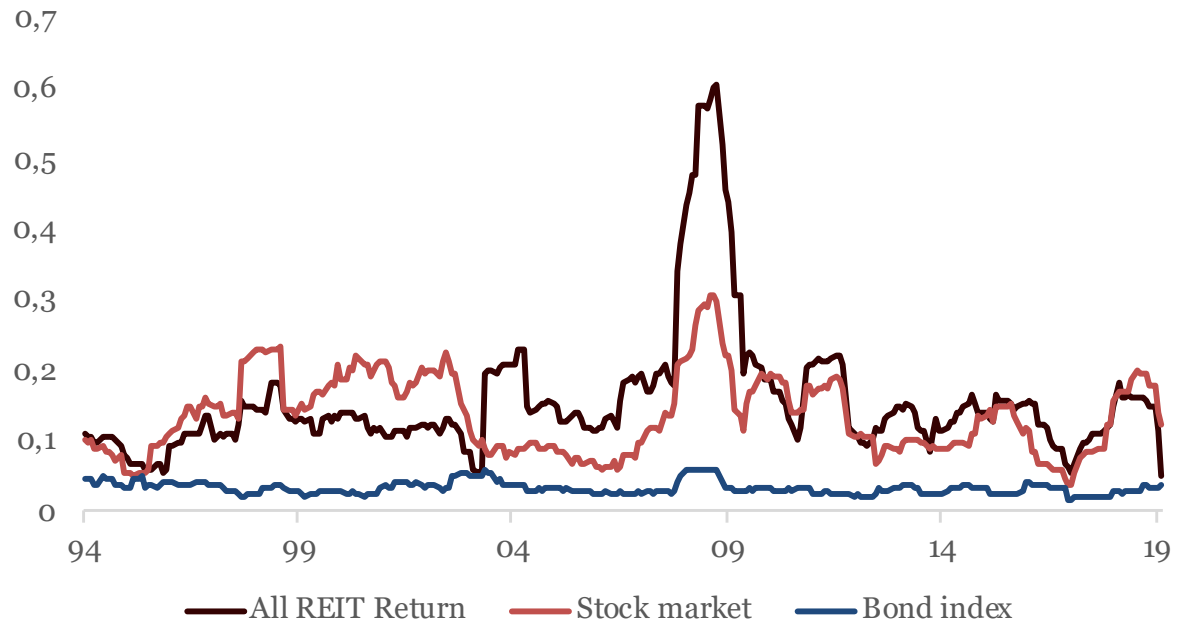
$\bar{x} = Sample\ mean$

$n = sample\ size$

Standard deviation (σ) is calculated as the square root of the variance, and used because it is a better parameter for comparing volatility between assets.

A one year moving annualized standard deviation is calculated for every month after December 1994. This is calculated as the standard deviation over the last 12 months for every month since January 1994. This calculation is made for the REIT index, the stock market index, and the bond index. The output can be found in figure 20. The output shows, perhaps surprisingly, that REITs were the most volatile asset class. This has a significant connection with the fact that REITs were even more volatile in the 2007-2008 global financial crisis than stocks and especially bonds.

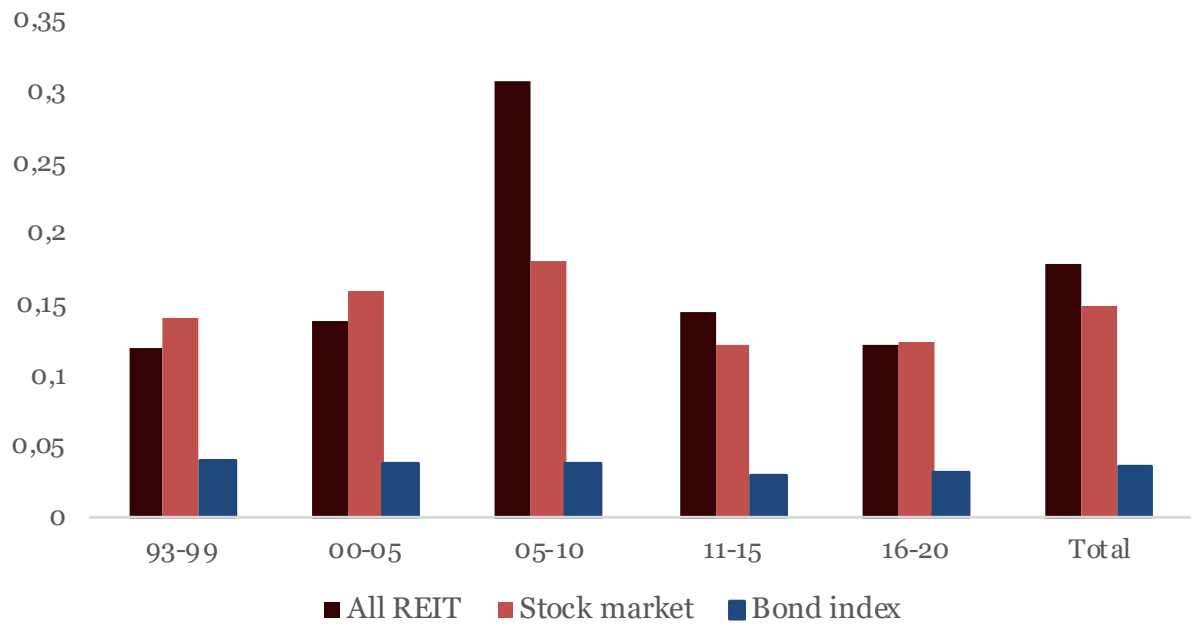
Figure 20: One-year moving standard deviations, annualized



Source: (Nareit, 2020c), (French, 2020), (Yahoo Finance, 2020)

It is even more evident when observing the standard deviation over five-year periods in figure 21. The stock market was more volatile than REITs in the periods from 1994 until 2005, but REITs were a lot more volatile during and shortly after the crisis. The real estate market was perhaps the segment affected most strongly by the crisis. Especially mortgage REITs, as an extreme amount of both residential and commercial mortgages defaulted. In the most recent time-period, 2016-2020, the REITs and stocks were back at the same volatility level. Still, in total, REITs had an annualized monthly standard deviation of 0.18 since 1994, slightly above the stock market with 0.15, and far above the bonds index with a standard deviation of only 0.04.

Figure 21: Annualized standard deviations over five-year periods



Source: (Nareit, 2020c), (French, 2020), (Yahoo Finance, 2020)

This volatility analysis indicates that over time there is not much difference in the standard deviation of REITs and stocks. REITs did have slightly higher volatility, but this does not seem to be significant, as the main reason is a specific crisis that happened to affect the real estate market more.

5.2.1.3 Correlation

When creating portfolios, the volatility of the individual assets in the portfolio is of limited importance. What really matters is the total volatility of the portfolio. The entire benefit of diversification is based on the notion that different investments follow different paths and are not correlating 100%. Thus, assets with a low correlation between them are good for creating portfolios with low volatility.

The correlation between two assets, x and y, is calculated as with the formula:

$$\rho_{x,y} = \frac{\Sigma(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\Sigma(x_i - \bar{x})^2 (y_i - \bar{y})^2}}$$

Where:

$$\rho_{x,y} = correlation\ between\ asset\ x\ and\ asset\ y$$

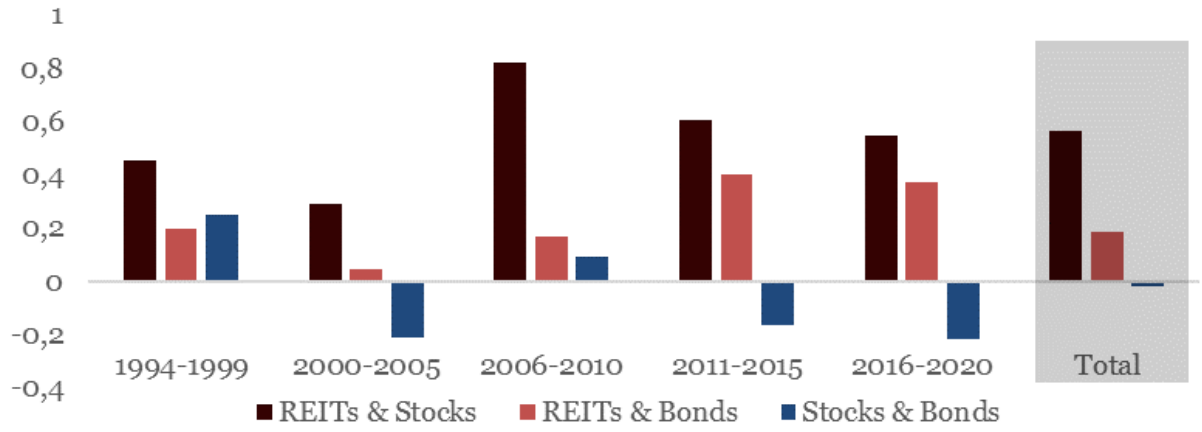
$$x_i and\ y_i = sample\ exess\ returns\ of\ asset\ x\ and\ y$$

$$\bar{x}\ and\ \bar{y} = mean\ exess\ return\ of\ asset\ x\ and\ y$$

$$Exess\ return = asset\ return - return\ of\ the\ risk\ free\ rate$$

The correlations between the three asset classes: REITs, stocks, and bonds, have not been constant over time. Considering the first period (1994-1999), it is notable that the difference in correlation between the asset classes was smaller. In this time, all the correlations were between 0.18 and 0.45, a spread of only 0.27. After 2006, the spread has been drastically higher, going from 0.72 in 2006-2010 to 0.77 in 2011-2020. One reason for this is that interest rates were higher in the 1990s, resulting in bond returns being more similar to that of REITs and stocks. Comparing this period to the others in figure 22, it is clear that the reason was the higher correlation between stocks and bonds in the first period and not lower volatility between REITs and stocks in the later periods.

Figure 22: Correlations between segments over time



Source: (Nareit, 2020c), (French, 2020), (Yahoo Finance, 2020)

Considering what the different periods have in common, it is evident that REITs and the stock market have the highest correlation among the asset classes in all the periods. This is not surprising, considering that REITs and stocks are both equities, and that the REITs are publicly traded and thus a part of the stock market. Since 1999, stocks and bonds had the lowest volatility, and this volatility is often even negative.

Most of the periods, the REITs & Bonds correlations have been somewhere between the REITs & stocks and the Stocks & bonds correlations. This shows that REITs' correlation with bonds is higher than stocks' correlation with bonds. In the interest rate section under *Macroeconomic factors* in chapter 5.1.3, it was found that real estate as an asset class has significant similarities with bonds. The correlations support this, as it shows that REITs historically have co-moved more with bonds than what stocks have. Thus, the argument that real estate can act as a hybrid between stocks and bonds is supported by historical evidence.

5.2.1.4 Beta

An asset's co-variance with the return of the market portfolio is denoted as beta (Petersen, Plenborg, & Kinserdal, 2017). Hence, beta is an asset's sensitivity to volatility in the market portfolio. Beta represents the systematic risk, and is, according to CAPM, the only risk an investor will be compensated for taking. Aswath Damodaran states that the market portfolio should represent the marginal investor's diversified portfolio (Damodaran, 1999). As most investors are heaviest weighted in stocks, the return of the stock market as a whole is used as a proxy for the market portfolio return. Thus, the group of stock indexes used to represent the stock market in the analysis also serves as the market portfolio.

The estimation of beta based on historical returns is found using a simple linear regression with the asset returns as the Y input and the market portfolio return as the X input. The slope of this regression represents beta. Beta can also be found using the formula given under CAPM in the theory section. Historical betas are found for REITs and bonds for horizons of 26 years (all the data), 10, five, and two years.

The return interval used for the calculations has a significant effect on the beta estimate. This is because assets do not trade on a truly continuous basis, creating a non-trading bias. This results in assets with high liquidity getting a higher beta estimate, while lower liquidity leads to a lower beta, everything else being equal (Damodaran, 1999). The solution for the non-trading problem is to use a monthly time interval of returns, so the difference in liquidity on the assets won't affect the beta estimates.

As most large investors will have a large exposure to the market, low-beta, or negative beta investments will be preferable from a diversification stance. This is simply

because an investment with high beta will amplify market movements, while a low beta investment will reduce the exposure to market volatility.

Figure 23: REIT, bonds and stock betas

Beta for different investment horizons					
Asset	**26 years**	**20 years**	**10 years**	**5 years**	**2 years**
REITs	0,68	0,78	0,69	0,50	0,48
Bonds	0,00	-0,02	-0,06	-0,06	-0,04
Stocks	1,00	1,00	1,00	1,00	1,00

Source: (Nareit, 2020c), (French, 2020), (Yahoo Finance, 2020)

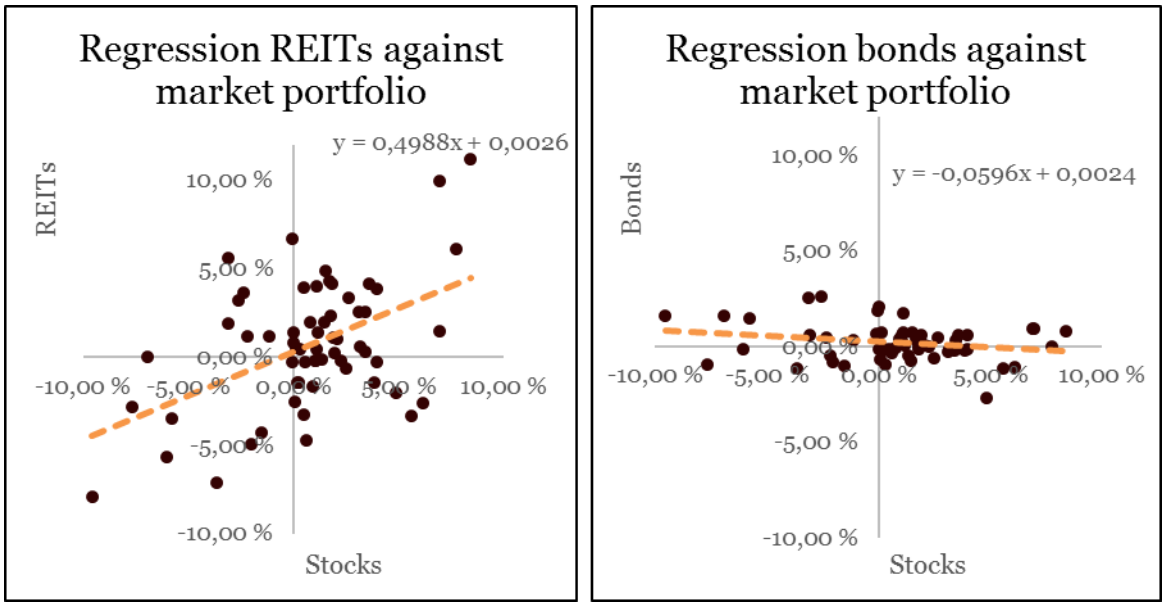
As seen in figure 23, the choice of horizon affects the beta estimates. The goal is to estimate the most representative beta for the future. Thus, the choice of period and horizon is a trade-off. To precisely capture the systematic risk, the beta-estimate requires a substantial amount of observations. At the same time, the market dynamics as well as the characteristics of both REITs and other companies are constantly changing. Furthermore, index constituents in both the REITs, bond, and stock indices are changing over time. The heavyweight companies of the indices in 1994 are to a large extent not the same companies that create the bulk of the indices today. Hence, the more recent data points are more representative of the future beta than the earlier data points (Damodaran, 1999). Because of this, the 26-year-old data points are not considered the most relevant. A regression should contain a minimum of 60 data points to provide a significant result and capture the true systematic risk (Koller, Goedhart, & Wessels, 2010). This criterion makes two years too short of a reference period.

The NAREIT All REITs index has added several subsectors of REITs over the years. The latest extension was in 2015 when data centers and specialty REITs were added to the index. There have been a few new single REITs added since then, but the index has been virtually the same since 2015. Hence, the index of the last five years is found to be the most representative of today's index.

The five-year time-frame includes only the bare minimum of data points according to Koller et al., and the 20-year time-frame includes data that may be too old to accurately represent today's markets. Hence, both perspectives have their pros and cons. In this trade-off they are at each end of the scale, and they both provide a good picture of how

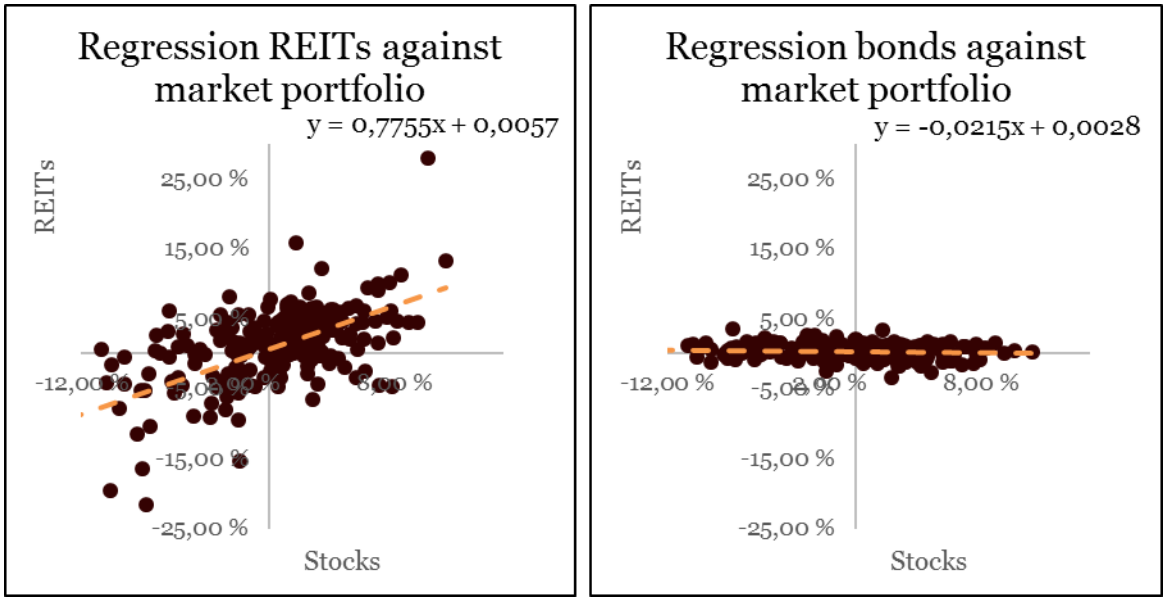
REITs have been connected to the market in the past, which could both be indicative of the future market beta. Because of this, the 20-year and five-year historical betas are given some extra focus.

Figure 24: Regression plots against the market portfolio, data from the last five years



Source: (Nareit, 2020c), (French, 2020), (Yahoo Finance, 2020)

Figure 25: Regression plots against the market portfolio, data from the last 20 years



Source: (Nareit, 2020c), (French, 2020), (Yahoo Finance, 2020)

Comparing the 5-year and 20-year regression plots in figures 24 and 25, the difference in the number of data points is evident. This shows how the 20-year beta has a more solid basis on data, which is also evident in the higher R^2. The bond's returns are a lot more unison, indicating a clear pattern. Still, bonds betas for both five and 20 years have insignificant R-squares of 0.05 for the five-year and 0.009 for the 20-year beta.

The regressions show that REITs have a low to medium beta in the range 0.5-0.78, while bonds have a slightly negative beta of -0.06 to -0.02. Considering the 5-year beta, this means that a 1% rise in market returns results in a 0.5% rise in REITs and a 0.06% drop in bonds. Conversely, a 1% fall in the market gives a 0.5% fall in REITs and a 0.06% rise in bonds. Based on this, REITs seem to work decently for diversification. Bonds however, seem to be a great way to diversify a stock portfolio.

Even though the beta estimates show that bonds are better for differentiation than REITs, the significance of the beta estimates is very different. The REIT estimation has a R^2 of 0.24. This is, according to Cohen J. (1992) a moderately high degree of explanation. Considering 20 years of data points, the degree of explanation was somewhat higher, with an R^2 of 0.36. The REIT beta also had a highly significant P-value, indicating that the true degree of explanation cannot, in fact, be zero. The bonds beta, however, had insignificant R-squares and a P-value of 0,08. This P-value indicates that the true degree of explanation could, in fact, be zero. The estimated bond beta is already very close to zero, so it is not surprising if the true degree of explanation is not statistically significant. Thus, the bond beta is found to be very close to 0, and the REIT beta in the range of 0.5 to 0.8.

5.2.1.5 Portfolio building

Following the modern portfolio theory (MPT), portfolios are constructed based on the historical return, volatility, and correlations of the three asset classes. For the chosen historical periods, tangency portfolios are found, giving the portfolio with the highest risk-adjusted return for each period.

These portfolios are constructed in four steps: The portfolio return is found as the sum of the product of the weights of the three asset classes and the historical returns from each asset class. The returns used are the average annualized excess returns over the relevant years for each asset class.

Portfolio standard deviation is then calculated with the following formula:

$$\sigma_p = \sqrt{w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + w_3^2\sigma_3^2 + (2w_1w_2Cov_{1,2}) + \left(2w_1w_3Cov_{1,3}\right) + (2w_2w_3Cov_{2,3})}$$

Where:

- w_1, w_2 and w_3 are the portfolio weights of REITs, stocks, and bonds
- σ_1, σ_2 and σ_3 are the historical variance of REITs, stocks, and bonds
- $Cov_{1,2}, Cov_{1,3}$ and $Cov_{2,3}$ are the covariance between the asset classes, calculated as:

$$Cov_{1,2} = \rho_{1,2} * \sigma_1 * \sigma_2$$

The portfolios' Sharpe ratios are then calculated as the portfolios' excess return divided by the portfolio standard deviation as shown in the Sharpe ratio paragraph under theory. Once these formulas are set up, the tangency portfolios are found through iteration, as the weights resulting in the highest portfolio Sharpe ratios. This is done with the Solver tool in Microsoft Excel.

The tangency portfolios for the different periods can be found in figure 26, and it is evident the weights are varying over time. This is not surprising, as both returns, volatility, and correlations have been fluctuating significantly over the 26 years observed. What is recurring, is that bonds are getting a bigger allocation than the other asset classes, with a portfolio weight of between 40% and 95%.

The ultimate situation for portfolio building is a negative correlation, as the volatility of the different investments will then offset each other. Thus, looking at correlations, bonds and stocks seem like the perfect combination for portfolio building. Historically, this combination has worked very well. Still, despite the negative correlation, bonds have become less attractive in many funds, as seen in the *analysis of existing asset managers* segment. This is once again because of the low returns from bonds in recent years. Bonds' negative correlation with stocks does not make a large impact on a portfolio's volatility if the bonds are barely fluctuating in value compared to the portfolio's other assets. For such bonds to make an impact big on a portfolio, the bond weight would have to be very high, and the investor would maybe even have to use leverage on the bond investments. This can be problematic because of two things; first, the high weight in bonds compared to stocks would be against the policies of many

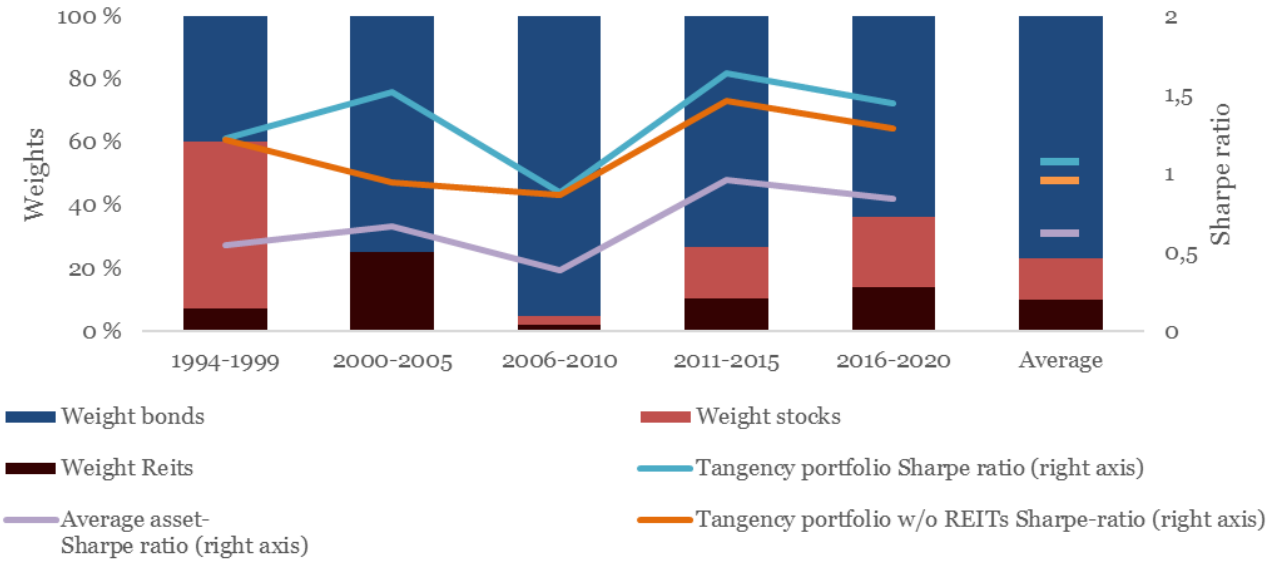
asset managers. Secondly, financial gearing on the bond investments would be impossible for many asset managers, especially pension funds, who have limited mandate for using leverage (Loader, 2016). Because of this, the tangency portfolios illustrated in figure 26 might not be optimal or realistic for all professional investors. However, in a world with no constraints, the best asset allocation for risk-adjusted returns based on the entire 26-year period would be a high weight of about 70% bonds, 18% Stocks, and 12% REITs.

Circling back to the portfolios of the large institutional asset managers, Prudential was the only asset manager who held as much bonds as the tangency portfolios. Except for Prudential, the average investment manager and SWF bond holdings were far lower, at between 25% and 45% in 2018. This is an indication that the high bond weights of ~70% are not realistic for real-world investors, which is further discussed in the sector analysis.

The development of the tangency portfolios' Sharpe ratios, illustrated with the purple line in figure 26, has been fluctuating as well. The highest Sharpe ratio was obtained in 2011-2015 when it was 1.64. The lowest was, not surprisingly, in 2006-2010, with a ratio of 0.88. Most years, it is the asset class with the highest Sharpe ratio that has the highest weight in the tangency portfolio. Conversely, in 2000-2005 and 2016-2020, REITs and stocks respectively had the highest Sharpe ratios among the asset classes, but the tangency portfolios still weighted bonds the heaviest in both those instances. This shows how important correlation is for portfolio volatility, and thus portfolio weights.

As illustrated with the blue line set against the purple line, the tangency portfolios always have a higher risk-adjusted return than portfolios consisting of equal parts REITs, stocks, and bonds. The tangency portfolios also have higher Sharpe ratios than the single asset class with the highest Sharpe ratio for all of the periods. This can be observed in the complete table showing weights and Sharpe ratios for all three asset classes in appendix one.

Figure 26: Tangency portfolios weights and Sharpe ratios over time



The Sharpe ratios are measured on the right-side Y-axis. Source: (Nareit, 2020c), (French, 2020), (Yahoo Finance, 2020)

To more directly showcase the effect REITs have on portfolio allocation, there has been constructed tangency portfolios for the same periods, but without REITs. Thus, REITs' effect on risk-adjusted returns is isolated and quantified. The tangency portfolios without REITs were constructed the same way as the other tangency portfolios, but the REIT weight is set to zero, and the optimal weights of stocks and bonds are then found through iteration to give the highest possible Sharpe-ratios without REITs. As illustrated with the orange versus the blue line in figure 26, the tangency portfolio with REITs had higher Sharpe-ratios than the ones without REITs. This was through the entire reference period, although the difference was marginal in 1994-1999 and 2006-2010, two periods where REITs underperformed compared to other stocks. The biggest gap was in 2000-2005, where the portfolio with REITs provided 61% higher Sharpe-ratio than the portfolio without REITs. For the last ten years, the difference was ~12%, and for the whole period, the average difference was 12.4%. This is a strong indication that for a mean-variance investor, a tangency portfolio with an element of REITs, historically, performs better than a tangency portfolio without REITs.

The most representative tangency portfolio

In the *beta* paragraph, the "last five years" and "last 20 years" time perspectives were both found to be useful indications for the future beta. Following this logic, the tangency portfolios based on the last five and twenty years of data should also be the most representative for future returns and volatilities of the REIT index, stocks, and bonds. The tangency portfolios based on historical returns and volatilities from the last five years and the last 20 years are calculated in the same manner as the other time perspectives.

The results are found in Figures 27 and 28 and it is evident that all the excess returns, volatilities, and Sharpe ratios are significantly different in the two perspectives. All over, both absolute and risk-adjusted returns were higher over the last five than the last 20 years. This is not surprising, as the 20 includes a global financial crisis while five is mostly bull market. REITs however, stick out with having higher annual returns over the last 20 than the last five years. Despite these large differences in risks and returns, the weights of the tangency portfolios are highly similar. The largest difference is the weight in stocks, which is almost double in the five compared to the 20 years' time perspective. REITs and bonds however, were weighed about the same for the two perspectives.

Figure 27: Tangency portfolio based on the last five years of data

Last 5 years				
Asset	**Weight**	**Excess return**	**Standard deviation**	**Sharpe ratio**
REITs	14 %	8,11 %	0,1257	0,65
Stocks	20 %	9,95 %	0,1232	0,81
Bonds	66 %	2,34 %	0,0328	0,71
Portfolio	**100 %**	**4,67 %**	**0,0377**	**1,24**

Source: (Nareit, 2020c), (French, 2020), (Yahoo Finance, 2020)

Figure 28: Tangency portfolio based on the last 20 years of data

Last 20 years				
Asset	**Weight**	**Excess return**	**Standard deviation**	**Sharpe ratio**
REITs	15 %	11,13 %	0,1935	0,58
Stocks	12 %	5,50 %	0,1501	0,37
Bonds	73 %	1,66 %	0,0347	0,48
Portfolio	**100 %**	**3,56 %**	**0,0436**	**0,82**

Source: (Nareit, 2020c), (French, 2020), (Yahoo Finance, 2020)

The optimal portfolio consists of about 15% REITs, 12-20% stocks, and 70% bonds. The return and Sharpe ratio of this portfolio will depend on the overall market but based on historical movements it produces an annual excess return of around 4% and a Sharpe ratio of approximately 1.0. An important takeaway is that even though the returns and risks of the market were completely different in the two considered time perspectives, the optimal tangency portfolio included almost exactly the same weight of REITs. This indicates that with a long time horizon, a 15% allocation to REITs can be good for the portfolio regardless of the economic climate. This optimal REIT weight of 15% is significantly larger than what the majority of large-cap investors are holding, demonstrating that most large-cap investors would benefit from investing more in REITs.

5.2.1.6 Portfolio reaction to the COVID-19 crisis

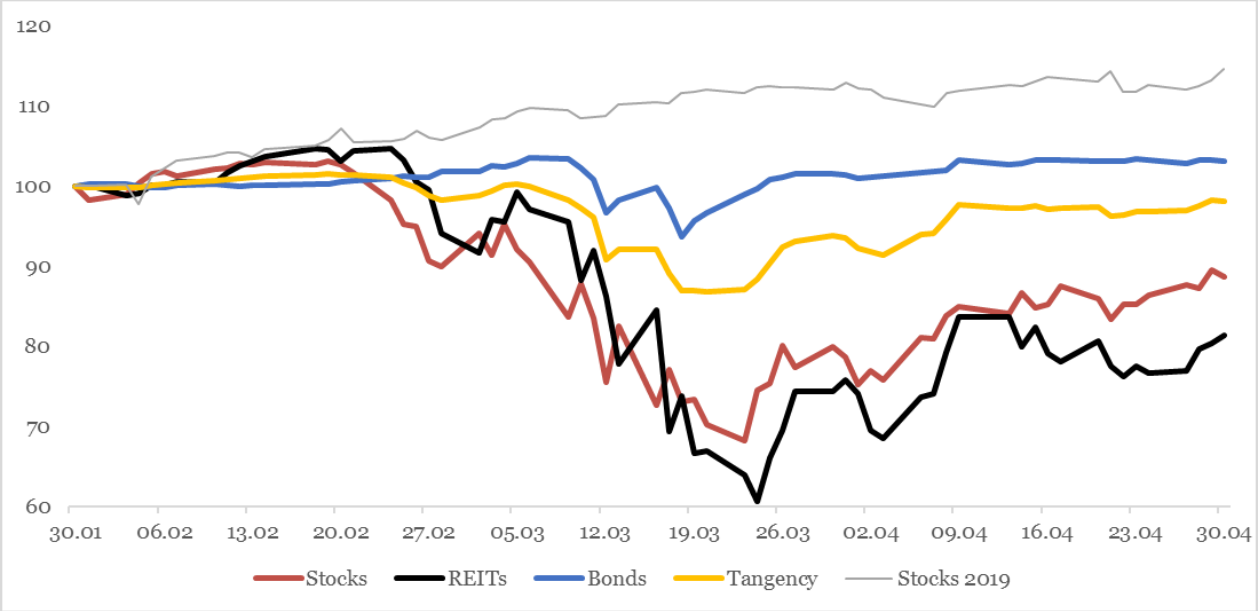
As of May 1st, 2020, stocks, REITs, and bonds all seem to have passed the worst part of the COVID-19 crisis, at least for now. Regardless of the final result not being known, the part of the crisis that has already passed offers interesting information about the asset classes' reaction to the crisis.

Figure 29 is indexed so that the asset classes and the tangency portfolio all start at the same level (100) on February 1st 2020. The daily returns indicate that the asset classes co-move similarly during the crisis as when the market was "normal". I.e. Stocks and REITs are still more volatile than bonds, and they also have a higher correlation with each other. This is where the similarities with the "normal" market conditions stop.

Not surprisingly, the three months from February through April have been extremely volatile. As seen in figure 31, compared with the standard deviations in figure 27, the annualized standard deviation of the stocks and bond markets were more than five times as high as the last five-year average. REIT volatilities rose even more, with an annualized standard deviation of 0.74, which is six times as high as its five-year average.

Since the market started turning downward on February 19th until the lowest point so far in the crisis: March 23rd (stocks), March 24th (REITs), and March 18th (bonds), the three asset classes had lost 34%, 42%, and 7% respectively. Since then, all three asset classes have improved significantly through April. The stock market did a spectacular rebound despite the high number of layoffs and general market uncertainty, resulting in the S&P-500 seeing its highest monthly return since 1987, and the best April return since 1938 (DeCambre, 2020). Because of this, as of May 1st, the losses were reduced, and REITs were down 22%, stocks were down 14%, bonds were up 1%, and the five-year tangency portfolio down 3% since the crisis begun to impact the market (Nareit, c, 2020) (Yahoo Finance, 2020) (French, 2020). As the two tangency portfolios have such similar weights, their returns have been about the same over the crisis. Because of this, only the tangency portfolio based on five years of data is included in the comparison.

Figure 29: 5y Tangency portfolio VS All REIT index, stock market, and bond market

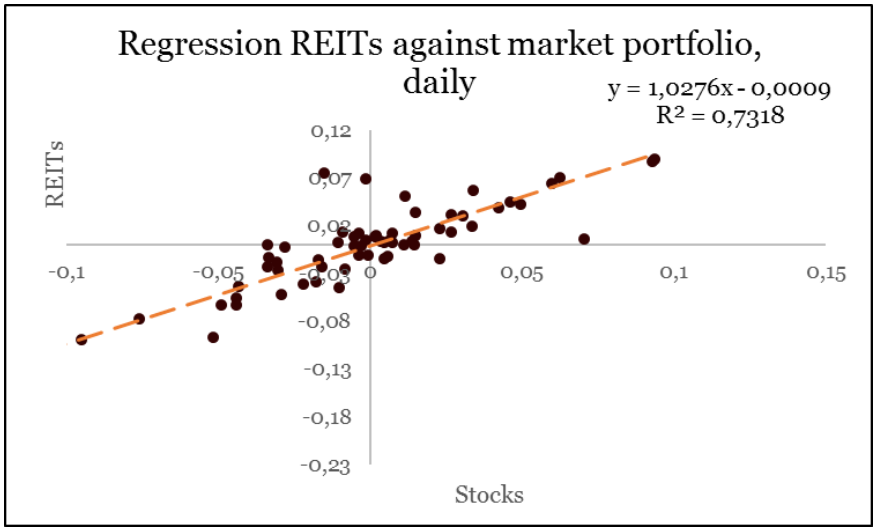


Source: (Nareit, c, 2020) (Yahoo Finance, 2020) (French, 2020)

In the "Beta" segment, it was found that the REIT index had a market beta of 0.5-0.8. This should indicate that when the market falls 14%, REITs should fall around 7-10%. Conversely, REITs fell 22%, proving the historical beta estimate drastically wrong. When an asset or index moves the same direction as the market, but to a higher degree than the market, it has a positive beta. Thus, from February to May seen as a whole, REITs have had a significantly positive market beta, which of course is the opposite of what investors want when they are seeking portfolio diversification. Calculations from the daily returns between February 1st and May 1st confirms this, as seen in the regression in figure 30.

REITs' market beta during the COVID-19 crisis has been 1.03, around twice as high as before the crisis. It is also worth noticing that the beta's coefficient of determination (R^2) now is 0.73, which is significantly higher than before COVID-19 (Nareit, c, 2020) (French, 2020). Both these parameters indicate that the reason REITs are falling is the general movements of the market and not changes in the underlying real estate assets.

Figure 30: REITs market beta and R2 from Feb to May



Circling back to the COVID-19 segment of the qualitative analysis, it was found that several real estate segments were doing relatively fine. For instance, house prices have not fallen, and data-centers and cell-towers are doing well. Intuitively, the same conclusion could be drawn from this as from the beta-analysis: It can seem like an overreaction that REITs prices are falling so much more than other stocks.

Figure 31: Annualized returns and volatilities in the COVID-19 crisis

Annualized from daily data, February to May 2020			
	Exess return	**Standard deviation**	**Sharpe ratio**
REITs	-43,05 %	0,74	-0,58
Stocks	-20,29 %	0,62	-0,33
Bonds	13,36 %	0,16	0,82
5y Tangency portfolio	**-4,92 %**	**0,20**	**-0,24**

Source: (Nareit, c, 2020) (Yahoo Finance, 2020) (French, 2020)

The pandemic is far from over, and there is a real possibility we have still only seen the beginning of the crisis' impact on the financial markets. Hence, this should not be interpreted as a final answer for which asset classes made it best and worst from the crisis. Still, as of May 1st, 2020, bonds were the undisputed winner between the assets analyzed. REITs have so far been doing the worst during the crisis, 22% down from the top in February. Overreaction or not, this indicates that in pandemic-induced financial crises where people have to quarantine, the markets punish real estate more than the average stock on the Nasdaq and NYSE.

5.2.2 Sector Analysis

The REIT sector has now been explored as a single entity, but there are differences and nuances within REITs across different sectors. In this paragraph, different REIT sectors will be analyzed and compared on their past returns, volatility, and the correlation between them and other assets. The sub-sector REIT indexes provide a more focused and detailed picture of the real estate market.

The sector analysis will have a time perspective of 20 years, from January 2000 to January 2020. The time interval is selected because some sectors do not have available return data before 2000.

5.2.2.1 Returns

Figure 32 shows the annualized average returns of each sector for the time interval. The period was very good for REITs, with every sector beating the performance of the stock index.

Figure 32: Annualized Average Returns, 2000 - 2020

Annualized Average Returns	Self-Storage	Health-care	Industrial	Residental	Retail	All REIT Return	Lodging	Office	Mortgage Home	Mortgage Commercial	Stocks
2000-2020	19,0%	17,8%	16,7%	15,5%	14,4%	13,5%	12,2%	11,7%	11,6%	8,0%	7,4%

Source: (Nareit, 2020c) (French, 2020)

To visualize the relative performance of each sector the returns are indexed in figure 33, for the years 2000-2020. The figure shows how superior the performance of Self-Storage and Healthcare have been in the period, which distorts and hides the performance of the other sectors. A logarithmic scale version of the graph can be seen in appendix two and shows that the various sectors experience much of the same variations in returns and mostly follow the same trend. The sectors differ in their sensitivity to those trends which results in large differences in total return over a 20-year period between some sectors.

Figure 33: Indexed Returns since 2000 by REIT sector

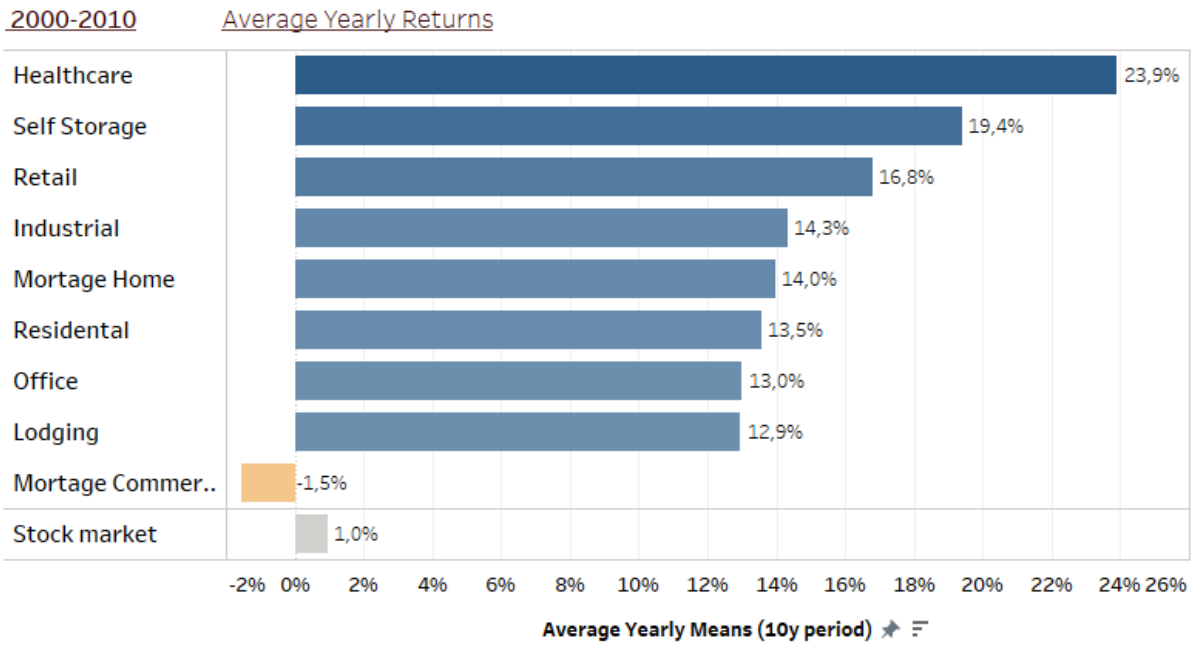
Source: (Nareit, 2020c) (French, 2020)

In the period 2000-2020 the best performing sectors where Self-Storage and Healthcare with annualized average returns of 19.0% and 17.8% over the period compared to the All REIT-index's return of 13.5%. On the other end of the scale are Commercial Mortgage and Lodging, only producing annualized returns of 3.2% and 6.5% in the same period. Stocks performed poorly compared to REITs during these 20 years with only a 6.2% annual return, only outperforming Commercial Mortgage REITs. Stocks' poor performance is due to two financial crises. The Dot-com in 2001-03 and the global financial crisis in 2007-08 which both saw the stock market fall over 40% from all-time high peaks.

In the years prior to the global financial crisis, all sectors performed very well, and where largely unaffected by the Dot-com bubble. In this period, Commercial Mortgage REITs outperformed stocks and all other REIT sectors, with average annual returns of 26.2% compared to an unweighted average of 16.7% for the other REITs between 2000-2007. As mentioned before, REITs were affected significantly by the global financial crisis of 07-08, and Commercial mortgage REITs were hit especially hard losing 90% of their value from the start of 2007 to the end of 2009. While REITs overall recovered quickly and had regained much of their losses by late 2010, mortgage REITs still have not recovered from their losses in the 07-08 crash.

In the ten years from 2000 to 2010, Healthcare was the best performing sector, returning average annual returns of 23.9%. Average annual returns are the average of all monthly returns in a given time period which are then annualized. In figures 34 and 35, the annualized average returns for each sector can be seen for two 10-year periods, confirming the image given by the indexed returns in figure 33. In the first decade, REITs where an overall very good asset, all outperforming stocks besides commercial mortgage.

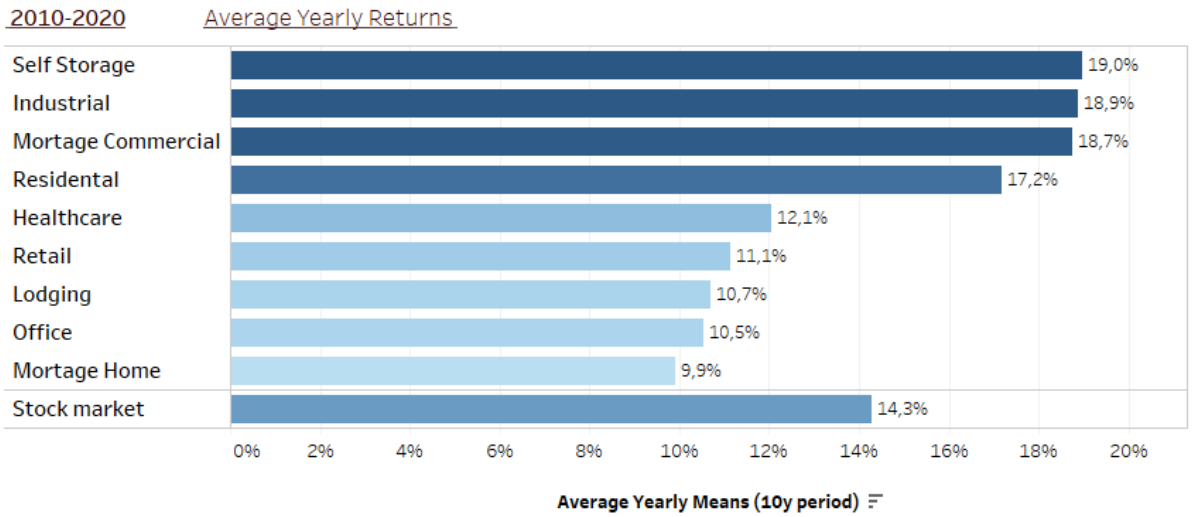
Figure 34: Average Yearly Returns, 2000-2010



Source: (Nareit, 2020c) (French, 2020)

Returns for 2010 to 2020 are graphed under in figure 35 and shows that Self-Storage continued to deliver high returns while Healthcare performed significantly worse than the previous decade. Industrial, Commercial Mortgage, and Residential are the best-performing sectors following Self-storage, with annual returns off around 18%. Commercial Mortgage performed much better as it was recovering from the crisis, returning 18,7% annually. As mentioned, 2010 to 2020 was a much worse period for Healthcare than the previous, with returns 12 percentage points lower. Retail is another sector that saw substantially lower returns, falling nearly 6 percentage points.

Figure 35: Average Yearly Returns, 2010 – 2020



Source: (Nareit, 2020c) (French, 2020)

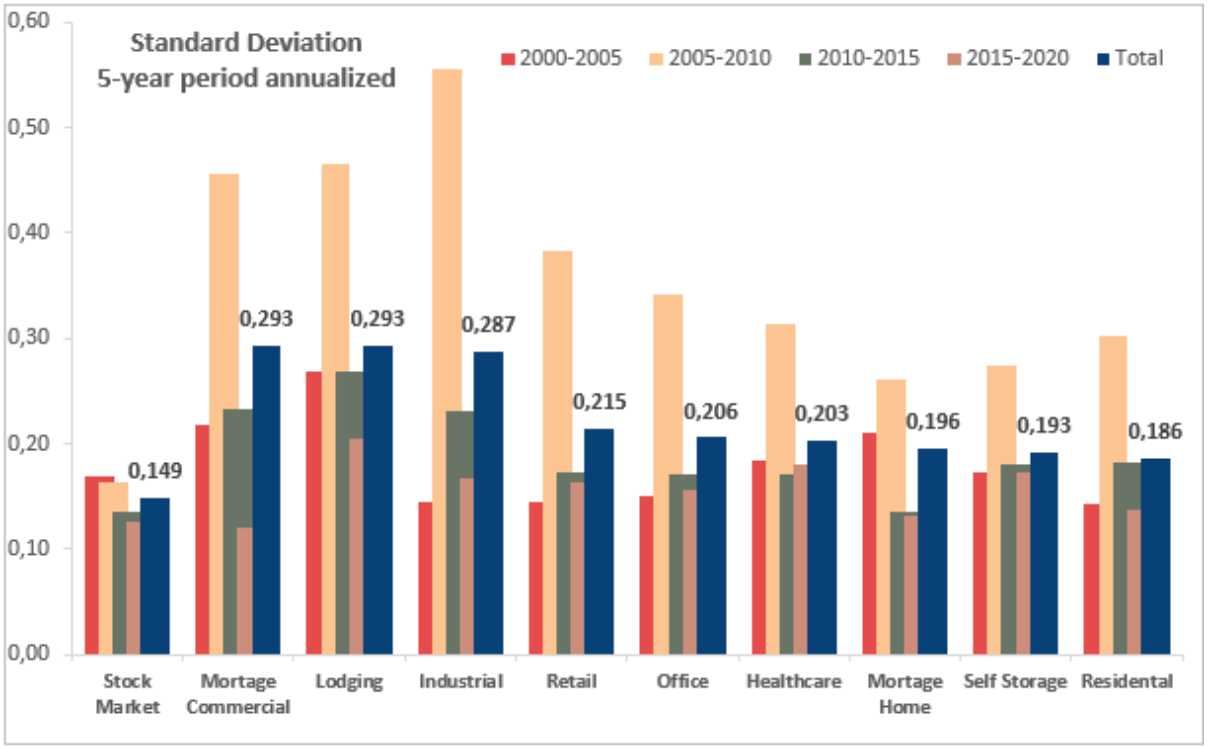
5.2.2.2 Volatility

To measure volatility in returns the annualized standard deviations are calculated for each sector. In modern portfolio theory, volatility is seen as a measure of how risky an asset is. Higher volatility in past returns is believed to indicate a higher risk for a portfolio. In figure 36, the annual standard deviation for each sector is shown for four time periods of five years. The volatility over time for each sector has followed the same trends as the All REIT index shown in section 5.2.1. The overall volatility increased drastically during the financial crisis of 07-08 before it leveled out at approximately the same level as before the crisis.

The sectors which historically have had the most volatile returns are Lodging, Industrial, and Commercial Mortgage. The three sectors all had returns with annual standard deviations of around 0.29 for the past 20 years. While the rest of the REIT sectors show standard deviations around 0.20 over the same period. Industrial and Commercial Mortgage returns were especially volatile during the financial crisis, with standard deviations of around 0.5. Both have since seen less volatility and are not among the sectors with the highest standard deviations the following decade. Lodging returns has been the most volatile of all sectors for all periods except between '05 and '10. Stock returns have been less volatile than all REIT sectors for the full period and also for most of the sub-periods of 5 years.

The least volatile sectors are the group of six to the right in the chart in figure 36, with similar standard deviations in returns. The two least volatile of them are Residential and Self-Storage at 0.186 and 0.193.

Figure 36: Standard Deviation per Sector, 5-year Periods Annualized



Source: (Nareit, 2020c) (French, 2020)

The Sharpe ratio of each sector for the last 20 years can be seen in the table below. The most volatile sectors also have the lowest Sharpe ratios, meaning that the investor has not been compensated for higher risk in these assets. Self-Storage and Healthcare have the highest risk-adjusted returns of the REITs and have much higher Sharpe ratios than stocks. Bonds does, however, have the highest Sharpe ratio of all the assets.

Figure 37: Sharpe Ratio 2000 - 2020

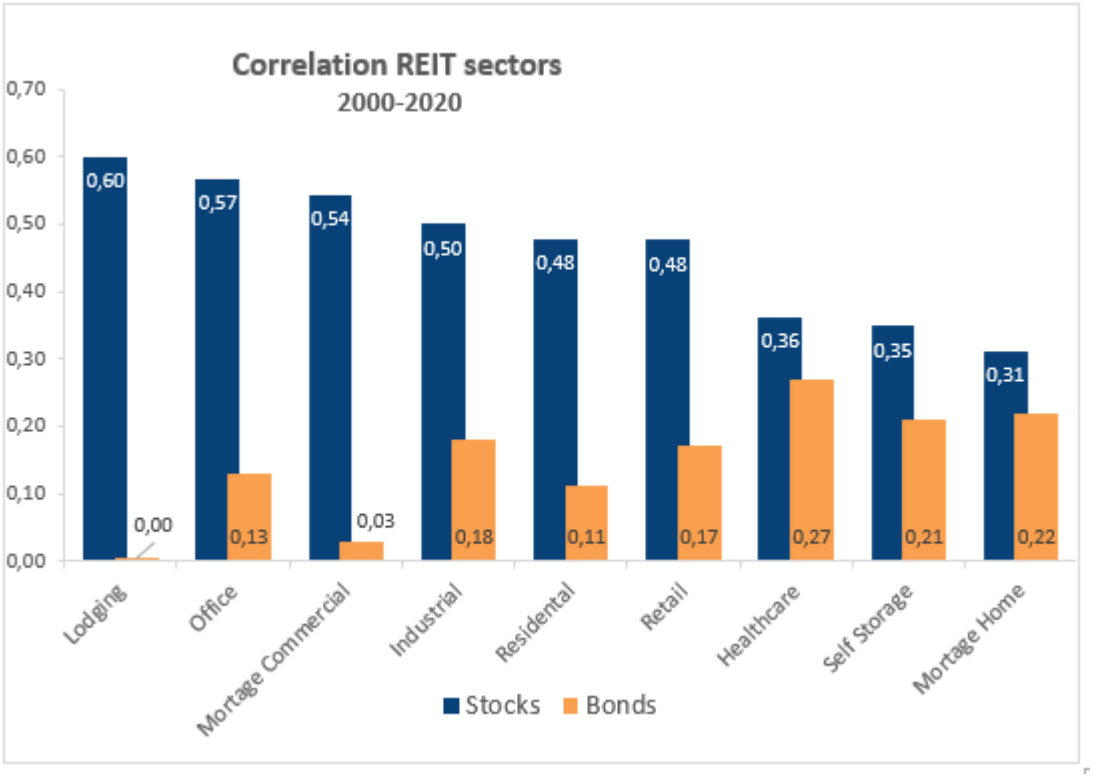
Sharpe Ratio											
Self-Storage	Health-care	Residental	All REIT Return	Retail	Mortgage Home	Industrial	Office	Lodging	Mortgage COM	Stocks	Bonds
0,85	**0,73**	**0,68**	**0,61**	**0,54**	**0,51**	**0,47**	**0,46**	**0,34**	**0,21**	**0,39**	**0,93**

Source: (Nareit, 2020c) (French, 2020)

5.2.2.3 Correlation

When looking at specific sectors to include in a portfolio the correlation with the rest of the portfolio is important to consider. In the graph under, correlation in returns between different REIT sectors and the stocks and bonds can be seen. Home Mortgage, Self-Storage, and Healthcare have the lowest correlation with stocks, while Lodging and Office have the highest correlation coefficient with stocks. Individual REIT sectors' correlation with stocks over time have not differed from the trend of the ALL REIT Index. Correlation for all sectors increased substantially for the years 2005-2010 and remained at a high level the following five-year period, before decreasing again between 2015-2020. For the last five-year period the correlation coefficient of Self-Storage and Healthcare decreased substantially more than the other sectors, to levels close to zero at 0.03 and 0.14.

Figure 38: Correlation of REIT sectors with stocks and bonds. 2000 - 2020



Source: (Nareit, 2020c) (French, 2020)

Bonds are another asset class often included in a portfolio and it is therefore also relevant to look at the correlation of REIT sectors correlation to bonds. Previously in the paper it was found that REITs' returns overall are more correlated with stocks than

with bonds, and it is, therefore, no surprise that all REIT sectors are less correlated with bonds than stocks. There is also a clear trend that sectors that are less correlated with stocks are more correlated with bonds.

Correlations between the sectors of REITs are as expected high, especially among the equity REITs. The Mortgage Home sector is considerably less correlated with the other sectors, with a coefficient of around 0.3 for most sectors. Among the equity REITs, Lodging and Self-Storage are the least correlated with the rest of the sectors, with coefficients of around 0.7 which is still high.

5.2.2.4 Tangency Portfolio

In this section, individual REIT sectors are added to portfolios to explore the differentiation benefit of them. The portfolios are constructed the same way as described in the previous chapter, but using data from individual sectors instead of the All REIT Index.

The portfolio that maximizes the Sharp ratio, also when individual REIT sectors are available, consist primarily of bonds. Under the assumption of no short sale and with no other constraints, the tangency portfolio for the time interval, 2000 – 2020, allocates 82.9% to bonds, 5.5% to stocks, and 11.6% REITs. Of the REITs, 8.9% are allocated to Self-Storage, 1.7% to Home Mortgage, and 1.1% to Residential. Tangency portfolios for different time intervals can be seen in figure 39 below.

Figure 39: Tangency Portfolio of bonds, stocks, REIT sectors.

	2000 - 2020	2010 - 2020	2015 - 2020
All REIT Return	0	0	0
Office	0	0	0
Industrial	0	0	0,769
Retail	0	0	0
Residental	0,0106	0	0
Lodging	0	0	0
Health	0	0	0
S-Storage	0,0886	0,0231	0
mCOM	0	0,026	0
mHOME	0,0169	0	0
STOCK	0,055	0,165	0
BONDS	0,8289	0,7857	0,2313
Sum	1	1	1
Sum REIT	11,6%	4,9%	76,9%
Mean, yearly	4,45%	6,11%	24,63%
Variance	0,0001	0,0001	0,0015
Standard Deviation	0,0106	0,0094	0,0384
Sharpe Ratio	3,28	5,97	6,15

Source: (Nareit, 2020c) (French, 2020)

Bonds have the highest Sharp ratio and the lowest correlation to any asset or sector and are therefore naturally the primary component in most of the portfolios. Stocks have as mentioned a lower Sharpe ratio than most of the REIT sectors, but stocks also have a small negative correlation with bonds which is preferable in a portfolio. Therefore, stocks still have a presence in optimal portfolios ahead of sectors that offer higher Sharpe ratios. Under different constraints to the minimum and maximum allocation to different assets (see appendix 7.3), the REIT allocation is made up of mostly of Self-storage, Home Mortgage, and Residential. Self-Storage is the favored REIT sector in most portfolios, as it has the highest Sharpe ratio. Even though it is also one of the highest correlated sectors to bonds which constitutes a major part of most portfolios.

The healthcare sector has the second-highest Sharpe ratio of the REITs but has the highest correlation with bonds of the sectors and is therefore not optimal in a portfolio with a large weight in bonds. If the allocation to bonds is restricted to a low level, Healthcare becomes a more attractive sector and is included.

The tangency portfolio for the period from 2010 to 2020 still consists of a large allocation to bonds, making up 79% of the portfolio. Stocks performed much better this decade and make up 16.5% of the portfolio. REITs made up just 5% of the portfolio, with Self-storage, still the largest component, while Healthcare is not included.

Looking at just the last five years, from 2015-2020, the tangency portfolio is very different. Industrial REITs have performed very well and have a much higher Sharpe ratio than any other assets, at 1.77 against the second highest at 0.93. The large SR of Industrial causes the tangency portfolio to allocate 77% to it, and 23% to bonds. If the Industrial REIT sector is excluded, the tangency portfolio weights are almost identical to that from the last 20 years, with 11.6% allocated to REITs, 68.3% to bonds, and 20.1% to stocks.

Overall, the inclusion of different REIT sectors to the portfolio building does not affect the overall allocation to REITs in any substantial way, compared to the All-REIT Index. The allocation to REIT sectors was a bit lower than to the All-REIT Index, but still at a similar level.

5.2.3 Multi-Factor Regression

The expected return of an asset reflects the compensation for the time value of money and risk. The most basic model for the relationship between risk and return is the CAPM model, in which exposure to market fluctuations is the only risk factor. There are, however, multiple models that explore different components that compensate for various sources of risk. The Fama French 3 factor model is perhaps the most well-known of these models. In this section, REIT's exposures to different systematic risks are explored to find out what kind of portfolios REITs fit best with.

In this section, a total of 8 different factors will be used to explain the excess return of REITs. The factor models used are the Fama and French five-factor model and Carhart's momentum factor. Additionally, two bond factors are explored as an attempt to capture REITs' sensitivity to interest rate changes.

The methodology for capturing interest rate exposure is based on the methodology of Van Nieuwerburgh in the article "Why are REITS Currently So Expensive?" (Van Nieuwerburgh, 2019). The article uses the 10-year constant maturity treasury bond rate as interest exposure as Van Nieuwerburgh claims it is the most salient for real

estate investors. This factor is denoted as GS10 in the models and referred to as treasury factor. The other bond factor is the Barclays Capital U.S. Aggregate Bond Index (AGG) used in other sections of this paper and gives exposure to investment-grade fixed-rate bonds in the US. This factor is denoted as a bond index in the models and is not used together with the treasury factor, as treasury bonds are a significant part of the bond index.

The complete risk factor model, with every factor included for expected excess return, is given by the following formula:

$$R_{i,t} - R_{f,t} = a_i + \beta_i\left(R_{Mt} - R_{f,t}\right) + g_i(R_{GS10} - R_{f,t}) + s_i SMB_t + h_i HML_t + r_i RMW + c_i CMA + \rho_i MOM$$

Figure 40 shows the results of the regressions on the excess return of the All REIT index as the dependent y-variable and the various factors as independent x-variables. The table shows the estimated beta coefficients for the various factors, as well as the p-value for the estimation. The table is divided into different combinations of factor models and factors in a multiple linear regression. The standard one-factor CAPM model in the first column shows a beta to the stock market of 0.78 which is significantly different from one. The two-factor model with the excess return on stock and the 10-year treasury, show a negative treasury beta, meaning that when the yield on interest increase, the REITs value decrease. The estimate is however not statistically significantly different from zero at significance level set at 0.05. The p-value of the treasury beta is 0.6353, which means that there is a 63.53% probability of obtaining a result at least as extreme given the null hypothesis, that beta is zero, is true.

Figure 40: Regression output on All REIT Index as dependent variable

	Mkt	Mkt + GS10	Mkt+Bond Index	FF3	FF3 + Bond Index	FF4	FF5	FF5 + Bond Index	FF6+ Bond index
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Alpha	0,00567	0,00820	-0,00031	0,00386	-0,00336	0,00410	0,00248	-0,00380	-0,00369
P-value	*0,0532*	*0,1781*	*0,9162*	*0,1493*	*0,2032*	*0,1269*	*0,3763*	*0,1638*	*0,1752*
Mkt-RF	0,78	0,78	0,81	0,75	0,79	0,72	0,80	0,81	0,78
P-value	*0,0000*	*0,0000*	*0,0000*	*0,0000*	*0,0000*	*0,0000*	*0,0000*	*0,0000*	*0,0000*
SMB				0,28	0,32	0,29	0,37	0,60	0,39
P-value				*0,0020*	*0,0001*	*0,0014*	*0,0004*	*0,0001*	*0,0001*
HML				0,56	0,61	0,54	0,48	0,60	0,55
P-value				*0,0000*	*0,0000*	*0,0000*	*0,0001*	*0,0000*	*0,0000*
RMW							0,24	0,12	0,15
P-value							*0,0710*	*0,3083*	*0,2347*
CMA							0,00	-0,06	-0,03
P-value							*0,9953*	*0,6829*	*0,8409*
Mom						-0,06			-0,07
P-value						*0,3113*			*0,1975*
GS10		-1,17							
P-value		*0,6353*							
Bond Index			1,47		1,72			1,69	1,68
P-value			*0,0000*		*0,0000*			*0,0000*	*0,0000*
R-Square (Adj)	35,9	35,7	42,5	47,2	56,3	47,2	47,5	56,2	56,3

Source: (Nareit, 2020c) (French, 2020) (FRED, 2020)

The last row in the table gives the adjusted R-square of the model. R-square gives the proportion of the variance in the dependent variable that is explained by the independent variables. The adjusted R-square is adjusted for the automatic increase adding more variables to the model leads to.

The table shows that the CAPM explains 35.9% of the variance in REITs, this is in line with the average explanatory power of CAPM on stocks, which is approximately 30-40% (Benninga, 2014, s. 92).

The treasury factor is consistently statistically insignificant and lowers the adjusted R-square coefficient of the model with various factors. The treasury factor explains no variation in the returns of the All-REIT index for all combinations of factor models and is therefore excluded from other multifactor models.

In the belief that some REITs have exposure to fixed income-oriented risks given the underlying businesses, another factor is added considering the treasury factor's

inability to explain variation. Regression against the bond factor and the market factor reveals that REITs have a high factor exposure against fixed income-oriented risk. The exposure is estimated to 1.47 and is highly significant. The R-squared increases around 6 pct. points from the CAPM-model, and 9 pct. points from the five-factor model.

Column 4 shows the result of the regression against the Fama French 3 factor model, where size and value factors are added. REITs have an SMB (small-minus-big) exposure of 0.28 and HML (high-minus-low) exposure of 0.56, which both are statistically significant, meaning that exposures to these risks explain parts of the return in REITs. The positive factor exposures to SMB and HML indicates that REITs behave like stocks with relatively low market capitalization and stocks with high book-to-market ratio. Intuitively it is expected that REITs have a high book-to-market ratio, as REITs are asset-heavy and required to have a high payout ratio.

The three-factor model increases the R-square of the model substantially, from 36% to 47%, compared to the CAPM. The alpha estimate for the CAPM was only just statistically insignificant with a P-value of 0.0532. The three-factor model gives a lower alpha estimate with a higher P-value, meaning it is less plausible that the estimate is different for zero.

Column 6 shows Carhart's four-factor model, in which a momentum factor is added to the Fama French 3 factor model. REITs have a small negative exposure to the momentum factor, but the estimate is insignificantly different from zero.

Fama French's updated five-factor model can be seen to not explain substantially more than the three-factor model, as R-square only marginally increases. REITs have a positive exposure against RMW, but the estimate is insignificant for all model compositions. The investment factor, CMA, does also give insignificant estimates, so neither RMW nor CMA have any explanatory power for the variation in REITs.

The alpha estimate becomes lower for each factor that is added to the regression, indicating that the factors explain more of the variation. The estimates are all statistically insignificant at confidence level 95%, indicating that REITs do not produce an additional return that cannot be explained by market exposure or other common equity risk exposure such as value and size. This may indicate that REITs do not have characteristics that set them meaningfully apart from other stocks, as their return can be explained by the same risk factors as stocks. This weakens the argument for that

listed real estate should be treated as an individual asset class the same way bonds and private real estate is.

The five-factor model does not add additional explanatory power over the three-factor model, and evidently REITs do not have exposure to the investment nor the profitability factor. The best model for estimating the expected return of REITs are therefore the three-factor model added the bond index factor. The full model with all the factors is, however, still used further down in the model, as it is deemed relevant to explore the factors that are on individual sectors as well.

5.2.3.1 Industry comparison

Figure 41: Regression output on various stock industries, 2000 – 2020.

	Cnsmr NoDur	Cnsmr Durbl	Manuf	Enrgy	HiTec	Telcm	Shops	Hlth	Utils	Other	REIT
Intercept	-0,001	-0,005	-0,001	-0,001	0,004	-0,002	0,000	0,001	-0,001	0,000	-0,004
P-value	*0,660*	*0,080*	*0,411*	*0,769*	*0,005*	*0,469*	*0,920*	*0,562*	*0,657*	*0,733*	*0,175*
Mkt-RF	0,75	1,28	1,14	1,01	1,15	1,00	0,95	0,74	0,62	1,06	0,78
P-value	*0,000*	*0,000*	*0,000*	*0,000*	*0,000*	*0,000*	*0,000*	*0,000*	*0,000*	*0,000*	*0,000*
Bond Index (A	0,34	-0,08	-0,05	-0,32	-0,29	-0,12	-0,03	0,20	0,91	-0,06	1,68
P-value	*0,012*	*0,731*	*0,618*	*0,276*	*0,043*	*0,539*	*0,842*	*0,283*	*0,000*	*0,511*	*0,000*
SMB	-0,06	0,49	0,17	0,11	-0,01	-0,29	0,12	-0,15	-0,18	-0,07	0,39
P-value	*0,240*	*0,000*	*0,000*	*0,319*	*0,853*	*0,000*	*0,035*	*0,042*	*0,035*	*0,055*	*0,000*
HML	-0,10	0,31	0,04	0,22	-0,52	-0,21	-0,04	-0,19	0,07	0,57	0,55
P-value	*0,118*	*0,008*	*0,413*	*0,104*	*0,000*	*0,018*	*0,519*	*0,030*	*0,461*	*0,000*	*0,000*
RMW	0,46	0,47	0,47	0,43	-0,42	-0,08	0,47	0,04	0,14	0,00	0,15
P-value	*0,000*	*0,000*	*0,000*	*0,003*	*0,000*	*0,393*	*0,000*	*0,701*	*0,179*	*0,940*	*0,235*
CMA	0,44	0,09	0,18	0,10	-0,25	0,37	0,08	0,45	0,47	-0,08	-0,03
P-value	*0,000*	*0,587*	*0,008*	*0,596*	*0,007*	*0,003*	*0,423*	*0,000*	*0,001*	*0,186*	*0,841*
Mom	-0,01	-0,33	-0,06	0,07	-0,11	-0,08	-0,04	0,06	0,10	-0,05	-0,07
P-value	*0,698*	*0,000*	*0,010*	*0,273*	*0,000*	*0,034*	*0,245*	*0,154*	*0,033*	*0,009*	*0,198*
R-Square	65,4	75,2	89,5	44,2	90,5	70,0	74,4	49,9	35,4	92,2	56,3

Source: (Nareit, 2020c) (French, 2020) (FRED, 2020)

To add perspective on the factor model regressions, the same has been applied to 10 different stock industries. The industry returns are value-weighted indexed returns from 10 different industries obtained from Kenneth French's data library (French, 2020). The description of the industries can be found in appendix 7.3.

REITs have a similar exposure to the market as Non-Durable consumer goods, Health care, and Utilities. These are all industries that intuitively are less exposed to market

downturns, as the products can be described as essential, and are among the last services that are cut in economic hardship.

REITs have among the highest exposure to size and value factors of the industries. The comparison underlines that REITs behave like small firms with considerable assets on their books. REITs are not exposed to the profitability, investment, or momentum factors. Six of the industries show significant exposures to profitability, in which all have positive exposure except HiTec. Industries with lower market beta seem to have a higher exposure to the investment factor, as the industries with the lowest beta to market have the highest significant exposure to CMA.

REITs have, as mentioned, very high exposure to the bond index, an exposure it is unique in having. Only Utilities have high positive exposure to the bond factor, which is not surprising as utilities, like REITs, are well known for high dividends. The implication is that REIT behaves more like investment grade fixed income products than other stock categories.

The R-squares of the model on the various industries show that the factors have relatively low explanatory power on REITs. While the R-squares on REITs are low, industries such as Energy and Utilities have lower. With the bond index factor added, the R-square of Healthcare is also lower. But, considering only the equity factors of the established models, the R-square of REITs is consistently lower.

By comparing REITs and various stock industries we can see that REITs' exposure to common factor models is not unique and further weakens the argument for REITs to be considered a unique asset class.

5.2.3.2 Sector exposures

REIT sectors are also explored using the same 7 factors as above, to explore inter-sector differences. The stock beta varies substantially across sectors, with Lodging and Industrial at the high end at 1.26 and 1.11, and Healthcare and Self-Storage on the low end at 0.51 and 0.49. The two mortgage REITs have very different exposures to the stock market, as home has the lowest beta at 0.41 and commercial are among the highest at 0.97. The exposure to the stock market beta can be interpreted as exposure to the economic cycle and would be consistent with how the sectors intuitively are perceived to be affected by economic conditions. Healthcare and Self-storage offer

services that are necessities and not something where the need and consumption increase or decrease with consumers' economic situation. Lodging is, however, especially exposed since a large portion of hotel stays are for vacations.

Figure 42: Regression output of various REIT sectors

	Office	Industrial	Retail	Residential	Lodging	Health Care	Self Storage	Mortage Commrc	Mortage Home
Intercept	-0,0051	-0,0066	-0,0053	0,0002	-0,0072	-0,0004	0,0022	-0,0060	-0,0028
P-value	*0,1060*	*0,1900*	*0,1501*	*0,9430*	*0,0576*	*0,9080*	*0,5637*	*0,1811*	*0,4587*
Mkt-RF	0,86	1,12	0,80	0,69	1,26	0,53	0,50	0,99	0,43
P-value	*0,0000*	*0,0000*	*0,0000*	*0,0000*	*0,0000*	*0,0000*	*0,0000*	*0,0000*	*0,0000*
BOND	1,52	2,80	1,97	1,28	0,84	2,40	1,77	1,30	1,51
P-value	*0,0000*	*0,0000*	*0,0000*	*0,0000*	*0,0143*	*0,0000*	*0,0000*	*0,0015*	*0,0000*
SMB	0,45	0,47	0,57	0,31	1,04	0,17	0,34	0,20	0,42
P-value	*0,0001*	*0,0085*	*0,0000*	*0,0077*	*0,0000*	*0,2003*	*0,0109*	*0,2103*	*0,0014*
HML	0,70	1,05	0,57	0,64	0,64	0,56	0,47	1,38	0,07
P-value	*0,0000*	*0,0000*	*0,0003*	*0,0000*	*0,0001*	*0,0007*	*0,0032*	*0,0000*	*0,6500*
RMW	0,16	0,06	0,28	0,08	0,61	-0,15	-0,03	-0,36	0,24
P-value	*0,2641*	*0,7814*	*0,0890*	*0,6000*	*0,0004*	*0,3771*	*0,8413*	*0,0757*	*0,1522*
CMA	-0,09	-0,64	-0,01	-0,11	0,14	0,04	-0,03	-0,21	0,17
P-value	*0,6073*	*0,0312*	*0,9769*	*0,5830*	*0,5358*	*0,8735*	*0,9023*	*0,4252*	*0,4463*
Mom	-0,07	-0,02	-0,17	-0,02	-0,47	-0,10	0,04	0,02	-0,10
P-value	*0,2416*	*0,8012*	*0,0140*	*0,7953*	*0,0000*	*0,1858*	*0,5704*	*0,8142*	*0,1421*
R-squared	54,6	45,3	47,4	40,7	68,0	32,8	25,8	48,8	19,8

Source: (Nareit, 2020c) (French, 2020) (FRED, 2020)

Van Nieuwerburgh (2019) found patterns in differences among sectors' exposure to interest rate factors that can be explained under a lease duration perspective. Sectors with typically long lease agreements, like Industrials and Healthcare, have higher exposure to interest rate changes. Sectors like Lodging and Residential which have shorter leases are less exposed to interest rate risk. In our data a similar pattern can be seen in the differences between sectors' exposure to the bond index AGG. Lodging has, at 0.84, far lower exposure to the bond index than any other sector, and Residential has the second-lowest exposure. Industrial and Healthcare have exposure coefficients at 2.80 and 2.40, which is far above the other sectors.

Exposures across sectors are the most consistent for the value and size factors. All sectors have positive significant exposure to size and value, except Healthcare and Commercial Mortgage for which the size factor is insignificant. Exposure to the

profitability and investment factors are for the majority insignificant, with only one sector having significant exposure to each factor. Relative to the difference in exposure seen across stock industries in the section above, the variation among REIT sectors are minor. Overall, all sectors trade like small value stocks that have much in common with bonds.

6 Conclusions

6.1 Alternative ways to invest in real estate

Real estate includes many asset classes, both the obvious like residential and offices, to the less obvious such as cell towers and timberland. Numerous specialized financial products will give investors exposure to the real estate market. This thesis has focused on the most common, which is direct real estate, and REITs.

Both direct real estate and REITs were found to have their pros and cons. Perhaps most notably, direct real estate tends to be highly illiquid, as it takes weeks or months of preparation, analysis, due diligence, and legal work to sell or buy a property. Publicly traded REITs allow investors to buy a share of a property or portfolio of properties, just like any other publicly traded stock. Thus, REITs allow investors to make more liquid placements in the real estate market. The throwback of course, is that REITs then become more volatile, and have a higher correlation with the stock market as a result of it being listed. The choice does, in a way, provide a trade-off between liquidity risk and market risk.

6.2 Optimal allocation for REITs in mixed-asset portfolios

The quantitative analysis is based on historical returns, volatilities, and correlations of hundreds of REITs, and thousands of stocks and bonds from the public American markets between 1994 and 2020. Investments have been ranked after their risk-adjusted returns, where the investments with the highest Sharpe ratios are regarded as optimal.

In the reference period, REITs had the highest returns, closely followed by stocks. Bonds were far behind in terms of absolute returns but for a lot of the time it had the highest Sharpe ratio due to its low volatility. For most investment horizons, REITs and stocks were interchanging having the highest Sharpe ratio. Still, REITs' relatively low

beta of around 0.5 towards the stock market and bonds give a diversification effect significantly improving the Sharpe ratios of the constructed tangency portfolios. For most of the different investment horizons and periods over the last 25 years, the highest risk-adjusted returns were achieved by allocating between 10% and 25% of the total portfolio to REITs. Judged by the two periods declared the most representative for the future, mean-variance investors should invest 15% of their total portfolio in REITs.

6.3 How do the sub-sectors of REITs contribute to portfolios?

The analysis of sub-sectors of REITs is executed similarly to the analysis of the All-REITs Index. The analysis shows that almost all REIT sectors have had higher average returns over the past 20 years, with especially Self-Storage and Healthcare performing very good returning over 15% annually. While REITs sectors have delivered good returns, the volatility in the returns has also been high. Sub-sectors of REITs have all been more volatile than the stock market, for all five-year periods.

Using the sub-sectors of REITs in the portfolio building did not change the weight allocated to REITs substantially. Bonds remained the biggest component of the optimal portfolio. The Sharpe ratio of the optimal portfolio did, however, get a much higher Sharpe ratio, than when using the All REIT index. This is mainly because this allowed for a higher weight of Self-Storage REITs, which had a much higher Sharpe ratio than the All-REIT index.

6.4 What investor types benefit more or less from real estate?

The analysis finds little consensus among large-cap investors' portfolios when it comes to real estate investments. Some managers held only 0.5% real estate, others held close to 25%. Traditionally, real estate investments have been popular among insurance companies and pension funds, as real estate's predictable and long term cash flows match these investors' predictable and long term expenses. Research of asset managers' portfolios found this to still be the case, especially when it comes to direct real estate. Based on this, it is found that investors who are more than averagely risk-averse, have a long investment horizon and an endurance for illiquidity could benefit from a high exposure to direct real estate. This group of investors includes family

offices, life insurance companies, pension funds, and mutual funds with a low-risk profile.

Conversely, investors with a shorter investment horizon, that need the ability to liquidate on short notice, are seeking higher returns, and has a higher appetite for risk should avoid direct real estate.

When investing in REITs, the illiquidity risk is lower, but the higher correlation with the stock market results in higher volatility and market risk. The fact that REITs are more similar to stocks also makes them more suiting for the common investor. The diversification effect historically made all mean-variance investors benefit from REITs. Thus, REITs are good assets for all investors seeking to maximize their risk-adjusted return. The exemption is investors holding large amounts of unlisted real estate, as they could perhaps get a larger exposure towards real estate than they are seeking. Unless the fund in question is one specializing in a specific asset, such as pure real estate funds, all large-cap investors should make sure to diversify their investments.

6.5 What are the effects of COVID-19?

At this point in time, nobody can yet know for certain what effects the COVID-19 crisis will have on the real estate market or REITs. So far, the crisis has affected some sectors strongly while others have been less affected. Hotels, shopping malls, and casinos are facing unparalleled losses, while a few REITs, mostly in the data-center and cell tower industry, have seen their market values rise during the crisis. Most REITs however have lost about as much or a little more than the over-all stock market, only with a slight delay.

The unlisted property market has not been the main focus of the thesis. It is also more difficult to accurately monitor this market. Yet, data from the private housing market was made available and has been analyzed. This revealed a far less dramatic change in the housing market than in REITs, as of May 2020. The housing market, just as REITs, is not a sufficient proxy for the whole unlisted real estate market. Still, the vast difference in COVID-19 reactions for the two markets does contribute to the notion that REITs may have dropped so much so far in the crisis because of their high short term correlation with the stock market, and not because of a collapse in underlying

property values. This shows that REITs did not offer any downside protection, at least not in the short term, during the COVID-19 crisis.

Bonds were down a lot less than the two asset classes, perhaps not surprising considering the low historical volatility. Because of the mixed tangency portfolio's high weight of bonds, the mixed-asset portfolio returned 3% from February 1st to May 1st. Considering the stock market was down 14% over the same period, this is a relatively solid return.

Bond investments have been increasingly unpopular after the 2008 financial crisis, as stocks have performed astonishingly well, and bonds have not. Even in this period, investment-grade corporate bonds have returned strong Sharpe ratios. As such, bonds have been an underrated asset class but was the savior of the tangency portfolio during the corona crisis. As more investors and analysis realize this, a long term effect of the COVID-19 crisis could be an upswing in bond investments.

There are plenty of different possible scenarios for the long term effects: Changes in where and how we want to live, work, travel, and shop could all be affected by the crisis. Some changes will probably be good for the real estate sector; other changes will be bad. The only thing that seems for certain, is that behavioral changes will cause alterations in the demand for real estate in a post-corona world and that real estate investors and operators will be wise to keep an eye on the future and take action to improve their portfolios in reaction to the changes.

6.6 Final Conclusion

To sum up, this thesis has found several answers to the main research question *Why should large-cap investors include REITs in their mixed-asset portfolios?*

REITs were found to be the simplest way to include diversified real estate investments into mixed-asset portfolios. Although REITs do not perform exactly like their underlying properties, they succeed in giving the investors some of the same exposure to the real estate market as direct real estate investments. These exposures include characteristics such as secure long term dividend cash flows, Low market beta, and a natural complete or at least partial hedge against inflation.

Focusing on the numbers, the quantitative analysis found that REITs had not been as stable and “boring” as most people, the authors included, would expect. In fact, since 1994, REITs had a slightly higher return and volatility than the total stock market. An investor owning only REITs over the last 20 years would have achieved a higher risk-adjusted return than an investor owning the market portfolio.

Still, to achieve the highest possible risk-adjusted return, investors will want to diversify, and mean-variance investors were found to be best off when holding about 15% of their assets in REITs. This can be done very easily, even without analyzing or doing any research as to what REITs to buy. Merely by investing in an index consisting of all publicly traded American REITs in combination with stock and bond indexes, investors will improve their risk-adjusted return compared to not including any REITs. This has been proved by analyzing historical returns and was the case for all different time perspectives after 1994.

Focusing on the big picture, real estate is a core asset class, and a big asset class: For most people, real estate is the asset representing the largest allocation of their total wealth. It is an asset that everyone will be dependent on for the foreseeable future; not only in the form of their home, workplace, schools, hospitals, and shops. But also because the production of goods is dependent on it and the postal and transportation services are dependent on it. Our phones wouldn’t work without cell towers, and without data centers the internet would collapse. Considering this, it is no surprise that such a fundamental part of our lives should also be part of most large-cap investors’ portfolios.

7 Appendix

7.1 Appendix 1, Tangency portfolios, returns, volatilities and Sharpe ratios of ALL REIT index, All stocks index, and bonds index

Total				
Asset	**Weight**	**Excess return**	**Standard deviation**	**Sharpe**
REITs	10 %	9,47 %	0,1794	0,52804
Stocks	13 %	8,37 %	0,1483	0,56462
Bonds	77 %	2,75 %	0,0359	0,7679
Portfolio	**1**	**4,16 %**	**0,0388**	**1,07224**
1994-1999				
Asset	**Weight**	**Excess return**	**Standard deviation**	**Sharpe**
REITs	7 %	2,23 %	0,1197	0,18673
Stocks	53 %	16,66 %	0,1403	1,18683
Bonds	40 %	1,08 %	0,0395	0,27347
Portfolio	**1**	**9,42 %**	**0,0772**	**1,22064**
2000-2005				
Asset	**Weight**	**Excess return**	**Standard deviation**	**Sharpe**
REITs	25 %	16,67 %	0,1402	1,18868
Stocks	0 %	-2,03 %	0,1598	-0,12725
Bonds	75 %	3,55 %	0,0377	0,94298
Portfolio	**1**	**6,83 %**	**0,0451**	**1,51392**
2006-2010				
Asset	**Weight**	**Excess return**	**Standard deviation**	**Sharpe**
REITs	2 %	5,05 %	0,3075	0,16422
Stocks	3 %	2,49 %	0,1816	0,13688
Bonds	95 %	3,29 %	0,0383	0,85752
Portfolio	**1**	**3,30 %**	**0,0375**	**0,87899**
2011-2015				
Asset	**Weight**	**Excess return**	**Standard deviation**	**Sharpe**
REITs	10 %	12,03 %	0,1457	0,82555
Stocks	16 %	12,12 %	0,1213	0,99895
Bonds	73 %	3,05 %	0,0289	1,05671
Portfolio	**1**	**5,46 %**	**0,0333**	**1,6401**
2016-2020				
Asset	**Weight**	**Excess return**	**Standard deviation**	**Sharpe**
REITs	14 %	9,17 %	0,1261	0,72706
Stocks	22 %	12,69 %	0,1233	1,02945
Bonds	64 %	2,42 %	0,0320	0,75605
Portfolio	**1**	**5,65 %**	**0,0391**	**1,44606**
Last 5 years				
Asset	**Weight**	**Excess return**	**Standard deviation**	**Sharpe ratio**
REITs	14 %	8,11 %	0,1257	0,65
Stocks	20 %	9,95 %	0,1232	0,81
Bonds	66 %	2,34 %	0,0328	0,71
Portfolio	**100 %**	**4,67 %**	**0,0377**	**1,24**
Last 20 years				
Asset	**Weight**	**Excess return**	**Standard deviation**	**Sharpe ratio**
REITs	15 %	11,13 %	0,1935	0,58
Stocks	12 %	5,50 %	0,1501	0,37
Bonds	73 %	1,66 %	0,0347	0,48
Portfolio	**100 %**	**3,56 %**	**0,0436**	**0,82**

7.2 Portfolios of REIT sectors with various constraints, 2000-2020

Constraint	No	Max 50% Bonds	Max 25% bonds	Min 30% Stocks	100% REITS
All REIT Return	0	0	0	0	0
Office	0	0	0	0	0
Industrial	0	0	0	0	0
Retail	0	0	0	0	0
Residential	0,0106	0,018	0,014	0	0,029
Lodging	0	0	0	0	0
Healthcare	0	0,015	0,058	0	0,102
Self-Storage	0,0886	0,270	0,435	0,174	0,609
Mortgage Commercial	0	0	0	0	0
Mortgage HOME	0,0169	0,114	0,186	0,010	0,260
STOCK	0,055	0,083	0,057	0,300	0
BONDS	0,8289	0,500	0,250	0,516	0
Sum	1	1	1	1	1
Sum REIT	11,6%	42%	69%	18%	100%
Mean	6,48%	10,04%	13,31%	8,15%	16,85%
Var	0,0001	0,0006	0,0013	0,0004	0,0024
Std	0,0120	0,0238	0,0358	0,0204	0,0491
Sharpe ratio	4,05	3,54	3,26	3,20	3,10

7.3 Industry Classification

Industry	Designation	Description
Consumer NonDurables	Cnsmr NoDur	Food, Tobacco, Textiles, Apparel, Leather, Toys
Consumer Durables	Cnsmr Durbl	Cars, TVs, Furniture, Household Appliances
Manufacturing	Manuf	Machinery, Trucks, Planes, Chemicals, Off Furn, Paper, Com Printing
Energy	Enrgy	Oil, Gas, and Coal Extraction and Products
High Tech Business Equipr	HiTec	Computers, Software, and Electronic Equipment
Telecom	Telcm	Telephone and Television Transmission
Retail	Shops	Wholesale, Retail, and some Services (Laundries, Repair Shops)
Health	Hlth	Healthcare Medical Equipment, and Drugs
Utilities	Utils	Utilities
Other	Other	Other - Finance, Mines, Construction, Building Material, Business Services, Entertainment, Transport

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