REIT Performance Relative to the Stock Market during the 2020 Pandemic

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Master Thesis Real Estate Studies

Abstract. Real Estate Investment Trusts (REITs) are an asset class that is often praised by investors for its diversification potential. Over the course of the 2020 Covid-19 pandemic, REITs experienced a substantial crash that occurred simultaneously with the stock market. This brings up the question whether or not REITs also provide a diversification potential in those times and to what extent they are impacted by the stock market. A vector autoregression is proposed in order to assess the relationship between 193 REITs and of the 500 largest stocks in the USA over the period from 2-1-2019 to 31-12-2020. In addition to REITs and stocks, the dataset contains variables for valuations, market capitalization and real estate properties. This research suggests that REIT performance is causally impacted by the S&P500, market valuation and market capitalization, explaining 32,3%, 19,2% and 3,5% of REIT performance respectively. Properties only account for 3% of REIT returns and is not a causal variable either. Therefore, REITs had limited diversification benefits and became correlated to the stock market in terms of their performance during the 2020 pandemic.

Keywords: *REITs, stock market, finance, portfolio management.*

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CONTENT

1. INTRODUCTION

1.1 Motivation

The first quarter of 2020 is characterized by an unprecedented degree of volatility and financial chaos, induced by the start of the Covid-19 pandemic. Over the course of a few weeks, the S&P 500 dropped by almost 35% and the Cboe volatility index, which tracks the expected volatility of the S&P 500, reached a new intraday record high, surpassing its previous peak from 2008 during the financial crisis. US REITs performed even worse, since the FTSE Nareit Equity REITS Index dropped by 46% (Tradingview, 2021).

REITs are perceived as a favorable investment from a portfolio diversification perspective (Tiwari et al., 2020). First, they enable investors to get exposure to international real estate properties without facing the drawbacks of direct real estate investment. These drawbacks include a low degree of diversification, high transaction costs and market illiquidity which makes it hard to buy/sell. Additionally, investment in direct real estate requires active management and the need for either equity or debt financing. Both of these come with additional effort and costs. Contrary to direct real estate, REITs don't require debt or equity financing and are already diversified among a wide variety of properties and sectors. The ownership structure of REITs is fragmented and therefore it is possible for small (retail) investors to invest into real estate. In addition, REITs are exchange listed securities which makes them accessible to a large pool of worldwide investors. A major advantage of this is high stock market liquidity, favorable bid-ask spreads and low transaction costs.

Second, Beasley (2020) points out that REITs are a useful hedge against stock market volatility because REITs are localized assets. Further, as REITs are securitized by physical real estate, they are perceived to be less affected by the broader equity markets due to their typical resilience to macro-economic factors (Jain and Upadhyay, 2021; Liu et al., 2012). REITs provide at least some protection against stock market downturns, as Simon and Ng (2009) indicate that REITs and stocks are less likely to fall simultaneously. Whether or not these portfolio benefits are also observed during the 2020 pandemic remains to be

examined. Hence, this research focusses on measuring the diversification benefits and performance of REITs relative to the stock market during the 2020 pandemic.

1.2 Literature review

REITs have been a widely discussed subject in earlier literature. Before focusing on REITs, it is important to define REIT performance. In the broadest sense, REIT performance relates to the relative difference in asset valuation compared to a pre-specified benchmark. This benchmark can be the current valuation of the asset itself, compared to the valuation of comparable asset at a specific point in history. For example, the price return over the past month or past year compared to the value of the underlying real estate. Another benchmark that can be used to compare performance is the Standard & Poor's 500 Index. The 500 companies in this index represent 80% of the total value of the US economy and are therefore a good proxy. The S&P500 has a historical annual return of 9.7%, including dividends and compounding (7,5% excluding dividends).

Now that the S&P500 has been determined as a benchmark for REIT performance, a link can be made with the market environment and diversification characteristics of REITs. First, we consider the relation between REITs and the market context under normal circumstances. Evidence suggests that REITs and stocks are positively correlated. A cause for this correlation with stocks is the increasing interest of large market participants in REITs during the last 3 decades. These large investors, like hedge funds, banks and pension funds, gradually adopted REITs into their stock portfolios, which makes REITs more prone to stock market performance (An et al., 2016). Because of this correlation with stocks, Tiwari et al. (2020) argue that REITs can be considered as a separate financial instrument, rather than a derivative of physical real estate. They make the assumption that REITs have a stronger correlation with stocks than with physical real estate and that the latter is unaffected by the stock market.

Second, the literature is inconclusive regarding abnormal market circumstances. In times of extreme conditions and market shocks that are characterized by financial chaos, high volatility and instability, a

positive correlation between REITs and stocks seems to be magnified. This is substantiated by Chiang et al. (2010), who conclude that REITs provide a low degree of defensiveness in times of crisis and instability. Simon and Ng (2009) argue that REITs do provide protection against stock market downturns and have a diversification potential. Although correlations are stronger during times of crisis, they conclude that REITs are an asset class on their own, being uncorrelated with stocks or bonds, and that the global financial crisis didn't affect the diversification benefits of REITs. On the contrary, Liu et al. (2012) not only consider REITs a poor hedge because of the increased correlation between REITs and stocks in times of crisis, but they also substantiate a weak correlation between REITs and economic factors like inflation and employment rates. This is supported by Tiwari et al. (2020), stating that REITs are more similar to stocks than to properties in terms of performance spillovers. Furthermore, these authors emphasize that performance spillovers can vary widely in their direction and magnitude over time. In sum; multiple researchers indicate that the desired diversification benefits for REITs are limited in times of crisis, while others conclude that diversification benefits are present in these times. Therefore, a consensus among researchers on REIT performance in times of crisis is limited.

1.3. Research problem statement

The research problem for this thesis is the fact that the impact of the 2020 market shock on REIT performance remains unclear. What differentiates the 2020 market shock from the previous shock following the 2008 global financial crisis is that the current crisis did not originate in real estate markets. This 2020 shock was induced by the Covid-19 pandemic, which caused a major economic crisis. Physical real estate remains unaffected by this crisis and the housing market in the USA even continued to grow in 2020 (Zhao et al., 2020). As REITs seem to be linked to both physical real estate and stocks, it is questionable whether REITs remain unaffected as well. Because this is such a recent event, so far no research has been conducted on the effects of the 2020 shock on REIT performance. Tiwari et al. (2020) indicate that during previous stock market crashes, housing performance spillovers to other assets were scarce (except during the global financial crisis). Therefore, they assume a low probability of a severe crisis affecting the real estate sector, endorsing its diversification benefits in the current financial

environment, at the time of writing in 2020. In addition, Wu et al. (2020) indicate that the exact influence of a so called “black swan” event, an unpredictable and rare event with severe consequences, on REITs remains unclear. Given its abruptness, the 2020 market shock is considered a “black swan” event as well. This makes it relevant to research if the correlation, spillover and contagion effects held this time as well, and if this is the case, to what extent they held.

The research aim of this study is to measure REIT performance during the 2020 stock market crash. Hence, the following central research question can be formulated:

How did the stock market affect REIT performance during the 2020 market shock?

To answer the central research question, the following sub questions will be explored:

1. What does theory tell us about REIT performance and the relation between REIT performance and the stock market?

This sub question concerns a literature study on this subject. It aims to give insight in the behavior of REITs, properties, stocks, eventual other assets and the relation between these different asset classes. Relevant theory would include both quantitative and qualitative research papers that are focused on examining REITs in the context of the financial markets, and in particular on REITs in the context of financial crisis. Relevant academic sources that are likely to be included are: *Journal of Real Estate Finance and Economics, Journal of Property Investment and Finance* and *Journal of Real Estate Portfolio Management.*

2. What was the exact impact of the 2020 market shock on REIT performance?

In the context of the conceptual model in figure 1, this sub question aims to analyze the effect of the 2020 stock market crash on the relation between physical real estate and REITs. As the time series variables have the potential to affect each other mutually in terms of their performance and can all be

considered endogenous, a Vector Autoregression (VAR) is the recommended method of choice (Brooks and Tsolacos, 2010). Beforehand, the Block significance test will be carried out and the optimal lag length will be determined using AIC. Then the VAR coefficients will be interpreted and based on the VAR, the exact impact the variables have on each other can be further explored by computing a Granger causality test and impulse response functions. The latter is especially helpful in analyzing observations over time, while the former determines whether or not variables have a causal impact on each other.

3. To what extent was REIT performance impacted by the 2020 market shock?

VAR will be applied to measure performance spillover effects by constructing the forecast error variance decomposition. The FEVD explains both total and directional variance spillovers between the 5 variables by indicating how much of each variable's variance is explained by the other variables. Therefore, the magnitude of the impact can be determined.

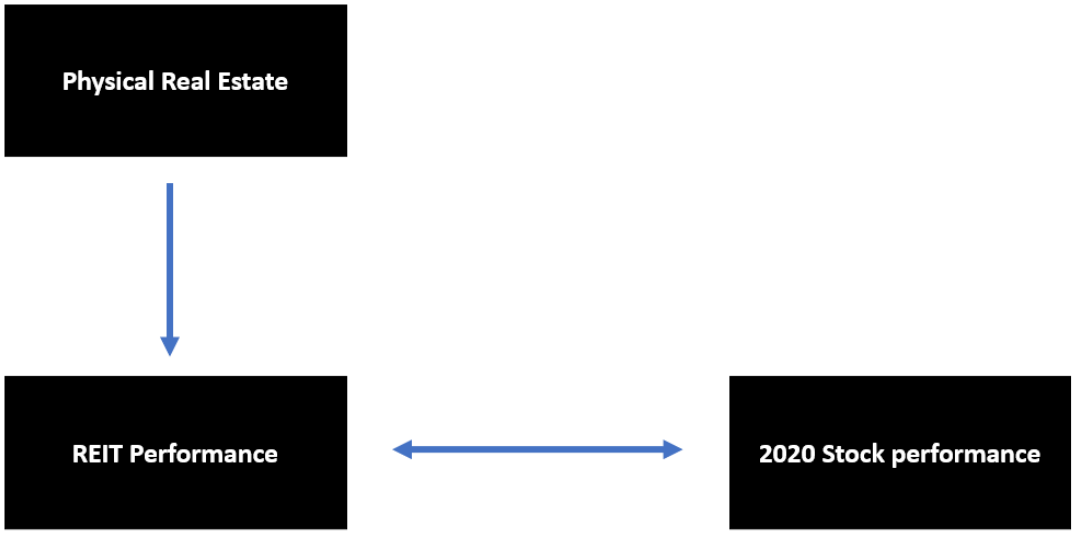

Figure 1: Conceptual model

Notes: *model explaining the relation between the 2020 stock performance, REIT performance, and physical real estate.*

2. THEORY

The theory section describes how REIT performance is measured and quantified; and how REIT performance is embedded in the market context. The theory indicates that REIT performance is related to both the underlying real estate and the market environment. What follows from the theory is the hypothesis that REIT and stock performance are positively related during the 2020 pandemic.

2.1 REIT structure

REITs are structured as an exchange traded fund that invests in real estate. REITs are established as independent corporation. This means REITs cannot own more than 10% of voting rights of another corporation. Furthermore, other corporations may not represent more than 5% of total assets of a REIT. An exception is made for REIT subsidiaries, as long as they don't make up more than 25% of a REITs total assets (Edwards, 2016). Therefore, a REIT can own multiple smaller REITs as subsidiaries which in turn improves the diversification benefits for investors. In order to be classified as a REIT, at least 75% of the gross income must be derived from the sale and/or holding of real estate assets. At least 75% of all assets should be invested in real estate properties (Gore and Stott, 1998). For a REIT to be eligible, it must have a minimum of 100 shareholders. In terms of ownership, 50% of the shares cannot be owned by fewer than 5 shareholders. REITs are obligated to distribute a minimum of 90% of taxable income as dividends to their shareholders. In practice, most REITs pay out as least 100% of their income as dividends in order to avoid taxation on the remaining 10% of income. If REITs meet the previously mentioned requirements, they are exempt from corporate income taxes (Ott et al., 2005).

There are 2 types of REITs: mortgage REITs and equity REITs. Mortgage REITs derive their return from issuing mortgage loans and other real estate debt instruments. Equity REITs derive their return from (re)developing, managing and maintaining real estate properties. Occasionally, REITs also sell real estate in order to buy new properties. The revenues that result from these properties are in the form of rents or capital gains after resale. These revenues minus the costs for acquisition, development,

maintenance and all other costs represent the REIT return. The real estate properties constitute the underlying value of the REITs (Block, 2011).

2.2 REIT market capitalization

The market capitalization of REITs will be discussed in the following section. REIT performance can be linked to both the market capitalization and the underlying real estate value.

Since REITs are an exchange traded instrument, they trade at a specific value on the stock market, referred to as market capitalization (market cap). The market cap is defined as the product of the share price and the amount of outstanding shares. As the latter is fixed for a considerable period of time, a REITs market cap is directly determined by the share price. Literary, the share price is the equilibrium of supply and demand of the company's stocks that are being traded in the market. If demand for shares is larger than supply, a buyer surplus exists and the share price will increase. If supply for shares is larger than demand, a seller surplus exists and the share price will decrease. This pricing mechanism of supply and demand is not only the case for REITs, but applies for any exchange traded security. Buyers and sellers base their investment decisions on a wide variety of different factors. A general method on which buyers and sellers base their decisions is by comparing the current market cap with the intrinsic market value of the company. The intrinsic market value (assuming a growing perpetuity) can be derived according to next year's annual dividend, the dividend growth rate and the expected return (Berk et al., 2019).

$$Intrinsic\ market\ value = \frac{Dividend\ payout\ at\ t+1}{Expected\ return - Dividend\ growth\ rate} \qquad (2.1)$$

The dividend payout of next year can be estimated by increasing the current dividend payout with the dividend growth rate. The expected return can be calculated using the Capital Asset Pricing Model. Equation 2.1 indicates that the intrinsic market value is based on discounted future cashflows. Since the

market cap (share price multiplied by the amount of outstanding shares) should theoretically constitute of the discounted future cashflows as well, an argument can be made that the market cap equals the intrinsic market value under the assumption of 100% market efficiency. Especially for REITs, the market cap is a fairly accurate representation of the underlying real estate value (Getry et al, 2003). Compared to other firms, the underlying real estate value of REITs is relatively efficiently reflected into the market cap due to their 90% dividend distribution (Fama and French, 1998; Jain and Upadhyay, 2021). In practice though, this dividend payout usually equals 100% instead of 90% due to tax benefits (Ott et al., 2005). Therefore, the dividend payouts are relatable to rental income of the underlying properties, while the dividend growth is relatable to the rental growth. From this point of view, the dividends of REITs are an effective proxy for the underlying real estate value and one can assume that the intrinsic market value is equal to the market cap. In the context of this research, REIT performance is defined as the change in market price (market cap / outstanding shares).

2.3 Benchmarking REIT performance

REIT performance is defined in relation to a benchmark, being the market environment. First, a proxy for the stock market performance needs to be defined. A common proxy for the market return is the S&P500 index, in which the 500 largest companies are included based on their market cap. This index is characterized by its validity and its adequate representation of the economy. According to the historical performance, S&P500 should return 7.5% annually without taking dividends into account. In addition to the S&P500, the Dow Jones Industrial Average is a popular proxy for the market return as well. This index was founded in 1896 and therefore the second-oldest stock market proxy in the USA. The index consists of 30 large American companies that are weighted according to their stock prices instead of market cap. With a historical annual return of 5.4% excluding dividends, the Dow Jones consistently underperforms the S&P 500 (S&PGlobal, 2021). The last popular index in the USA is the NASDAQ Composite. This index holds over 2.500 companies that are weighted according to their market cap. The NASDAQ is known for its emphasis on technology stocks and it's skewed distribution, since the 10 largest stocks account for 55% of the market cap. Because of its riskier nature, the NASDAQ

tends to outperform the other indices with an annual historical return of 10.2% excluding dividends (NASDAQ, 2021). In the context of this research, the S&P 500 will be used as a market proxy since it is the most comprehensive.

Second, one can consider how REIT performance is embedded in the market context. Since REITs are publicly listed on the stock exchange, they are subjected to the forces of supply and demand of the stock market. The magnitude of these market forces varies over time and depends on market conditions (Chiang, 2010). These market conditions relate to normal conditions, characterized by low volatility and stability, and abnormal conditions, characterized by high volatility and chaos.

On the one hand, the correlation between stocks and REITs is low under normal market conditions. Instead, REIT performance is determined by the underlying real estate. This can be attributed to the large proportion of dividend that is distributed to the shareholders. Since the minimum dividend distribution is already 90% of the income, a relatively large amount of information about the firm is reflected into market prices. Thus, REITs are priced efficiently conform their underlying value (Fama and French, 1998). As the large distributions also mitigate information asymmetry between managers and shareholders. This also improves pricing efficiency and supports the low correlation with the stock market (Jain and Upadhyay, 2021). Especially in the long term, interdependence between REITs and stocks is low and REIT performance is closely related to the underlying real estate. REITs then provide considerable diversification benefits (Hoesli and Oikarinen, 2012).

On the other hand, the correlation between stocks and REITs positively increases under abnormal market conditions. The market correlation of REITs increases with increasing market volatility and decreasing equity trading volume (Liu et al., 2012). This is attributed to the fact that high volatility and liquidity shifts tend to overflow into REITs when a market shock occurs (Subrahmanyam, 2007). The increased correlation with the stock market during abnormal conditions obscures the connection of REITs with their underlying real estate. This can be attributed to performance spillovers during a market shock. These spillovers are more prevalent between REITs and stocks than performance spillovers between

REITs and properties, despite the fact that the latter represents the underlying value of the REITs (Tiwari et al., 2020). As new information is reflected almost directly into financial markets, stocks and REITs are among the asset classes that are the first to be affected by market shocks. For physical real estate, it takes relatively long for information to be reflected into price. REITs then become more impacted by stocks than by physical real estate and lose their diversification benefits. As a consequence, real estate and REIT valuations diverge from each other due to market shocks. This phenomenon only holds in the short-term though, as they tend to move back into equilibrium in the long-term. So when a market shock occurs, REITs lose their diversification potential in the short-term, but regain their diversification advantage in the long-term as the connection with their fundamentals is restored (Boudry et al., 2012).

Besides the previously discussed market conditions, there are other market forces that affect REIT performance: institutional ownership, valuations and market cap. As the popularity of REITs increased among retail investors over the past 30 years, so did institutional interest. An et al. (2016) find that institutional ownership of US public equity REITs increased from 14.14% in 1990 to 75.19% in 2011. As REITs grew their market cap during the 1990s, so did they grow in terms of liquidity. Institutions generally manage large sums of money, so they require a market that is highly liquid in order to successfully fulfill their large buy- and sell orders. Furthermore, institutions can avoid the additional costs of high bid-ask spreads by investing into liquid assets. Since REITs meet this requirement as well from 1990 onwards, they were gradually accepted by large market participants and adopted into institutional stock portfolios. Consequently, REITs became more correlated with the stock market. The result is that during financial chaos, REITs correlate to stocks because institutions start selling their portfolios and move the proceeds into less risky cash positions (Das et al., 2015). This is particularly the case during market shocks, when risk tolerant institutions like banks or mutual funds significantly increase (short) selling pressure. For example, for every standard deviation in bank trust ownership, the crash risk of REITs increases with 5.4%. This is attributed to the fact that these institutions pursue aggressive investment strategies, characterized by frequent trading, short selling and speculation in order to maximize returns. However, the subsequent price recoveries after a market shock will be strong as well due to institutional buying (An et al., 2016). Thus, institutional ownership establishes the relation

between stocks and REITs and is therefore an necessity in order for a correlation to occur between these 2 assets.

Other than institutional ownership, REIT performance is affected by market valuations because undervalued REITs have the tendency to perform better than overvalued REITs. This is due to the fact that investors tend to overreact to negative and positive news and based on long-term performance instead of short-term performance. They take a relatively long period of time to form an opinion on REIT performance. As a consequence, investors continue to buy good performers and continue to sell or short bad performers, until the former becomes overpriced and the latter becomes underpriced. This overreaction is of asymmetric manner, suggesting that investors tend to overreact more to negative news compared to positive news. Ultimately, the undervalued firms will start to outperform the overvalued firms. Hence, the best performing firms over the past 3 years become the worst during the following 3 years and vice versa (Zhou and Ziobrowski, 2009). The assumption that undervalued firms tend to perform better than overvalued firms is supported by Fama and French (1993). Companies that are considered as undervalued tend to have a high book-to-market ratio. These "value" companies are perceived to be trading at lower price than their intrinsic value. Therefore, undervalued companies provide higher returns than overvalued "growth" companies. The latter have a low book-to-market ratio and therefore trade at a market premium compared to their fair value. Fama and French introduce the concept of valuations as the High Minus Low (HML) variable in their models. The HML variable represents the valuation premium by subtracting the returns of companies with low book-to-market ratios from the returns of companies with high book-to-market ratios.

In addition to valuations, Fama and French conclude that market cap affects performance in a similar manner. This means that small cap stocks have the tendency to outperform large cap stocks in the long term. This phenomenon can be attributed to the fact that small cap firms still possess significant growth potential and because investors demand a premium due to the riskier nature of small sized firms. Market cap is reflected by the Small Minus Big (SMB) variable. The SMB variable is calculated by subtracting the returns of big companies from the returns of small companies. At first glance, the HML and SMB

variables might imply that they should be retrieved from REITs themselves and thus seem to be unrelated to market forces. However, founder Kenneth French calculates the HML and SMB based on his 6 stock portfolios. The constituents of these portfolios represent the entire NYSE market equity. Hence, the HML and SMB can be considered a proxy for systematic risk and consequently relate to stocks affecting REIT performance (Fama and French, 1993).

In short, there are 4 key drivers affecting REIT performance: underlying real estate, the stock market, market cap and market valuations. The underlying real estate determines REIT performance during normal market conditions. Under abnormal market conditions, REITs will lose the connection with their fundamentals and become positively correlated to stocks. Lastly, both market cap and valuations are affecting REIT performance. In order for a correlation to occur in the first place, a substantial amount of institutional ownership is required.

2.4 Predictions

Based on the previously discussed theory, one can predict that REITs are likely to be positively related to the stock market during start of the 2020 pandemic when conditions were abnormal. This suggests a loss of diversification benefits for REITs. An argument can be made that REITs have a stronger correlation with stocks than with the underlying real estate during the 2020 pandemic. Subsequently, before the 2020 pandemic when the market conditions were normal, REIT performance is likely to positively relate to physical real estate. Furthermore, once can predict that undervalued small cap REITs outperform other REITs during the 2020 pandemic. Institutional ownership is an necessity for the correlation between REITs and stocks and therefore can be considered a control variable. Thus, the following expectations can be formulated:

1. REIT performance is more positively correlated to the stock market during the 2020 pandemic, compared to before the 2020 pandemic.

2. REIT performance positively correlates to both undervaluation (HML) and small market cap (SMB) during the 2020 pandemic.

3. DATA & METHOD

3.1 Data source

The gross sample data source that is used are the historical daily closing prices from 2-1-2019 to 31-12-2020 and contains the S&P500 Index and all REITs listed on the NYSE and NASDAQ. As a proxy for physical real estate, the PHLX Fannie Mae and Freddie Mac price index will be used. The 2019 data series is included to compare the 2020 data to a pre-pandemic benchmark as a robustness check. Because the stock exchange is not open on weekends and holidays and because 2020 is a bissextile year, the sample includes 252 observations for 2019 and 253 observations for 2020 (total of 505 observations). Daily returns concerning the HML, SMB and the 1-Month Treasury Bill rate are gathered as well. Additional background data about the REITs include industry sector, market cap, dividend, institutional ownership, dividend growth, outstanding shares, country of origin, beta and price-to-book ratio. In 2021, a total of 179 REITs are listed on the New York Stock Exchange. In addition, there are 30 REITs listed on the NASDAQ that are also included. This brings the gross sample to a total of 209 REITs. After adjusting for missing values and removal of REITs that weren't listed yet at the start date of the sample, the 193 REITs that remain in the net sample represent a total market cap of $1.421 billion, accounting for over 99% of the total REIT market in the USA (Frankel, 2020). All market data is retrieved from Yahoo Finance, Google Finance and Kenneth French's data library (French, 2021). All companies in the sample are registered in the USA, except for 1 Canadian company: Granite REIT. Nevertheless, 50% of Granite's portfolio is allocated in the USA (Granite REIT, 2021). This explains why it is the only Canadian REIT which is listed on the NYSE and therefore it is not excluded from the sample. This research focusses on the markets in the United States, because this is the largest economy in the world. The US market also houses the world's largest stock exchanges and largest market for REITs. Therefore, the USA is considered the most influential and leading market on a global scale. A complete list of the 193 REITs in the sample can be found in appendix C.

3.2 Descriptive analysis

The descriptive statistics of the 5 variables are presented in table 1. These 5 variables are denoted as:

%REIT = daily return of the weighted index consisting of the 193 REITs.

%S&P500 = daily return of the S&P500 Index.

%SMB = Small minus Big market cap; daily return of the SMB.

%HML = High minus Low Book-to-Market ratio; daily return of the HML.

%PRE = Physical Real Estate; interpolated daily return of the FMFM Index.

The 10 biggest REITs in the sample account for 39.7% of the total market cap. The top 4 biggest companies are American Tower Corporation, Prologis, Crown Castle Int. Corporation and Equinix, with a market cap of 7.7%, 6.0%, 5.6% and 4.5% respectively. American Tower Corp., Crown Castle and Equinix are specialty REITs that are all related to communications infrastructure and technology. Prologis is specialized in logistics and belongs to industrial REITs. The 193 REITs in the sample are distributed among 9 different industries. This distribution is presented in figure 2. Mortgage REITs represent 5% of the sample, while the remaining 95% are classified as equity REITs. All REIT industry names speak for themselves in terms of their content, except for the specialty REIT. Since it is not specifically clear what "specialty" represents, it is relevant to elaborate on this by looking at the included REITs in this industry. The 4 biggest companies in the REIT specialty industry make up 75.4% of this industry and are all related to communication and IT infrastructure. Their portfolios consist of data centers, broadcast towers, smalls cells and fiber networks. Therefore, the performance of the REIT specialty industry is strongly connected to the IT communications and technology sector.

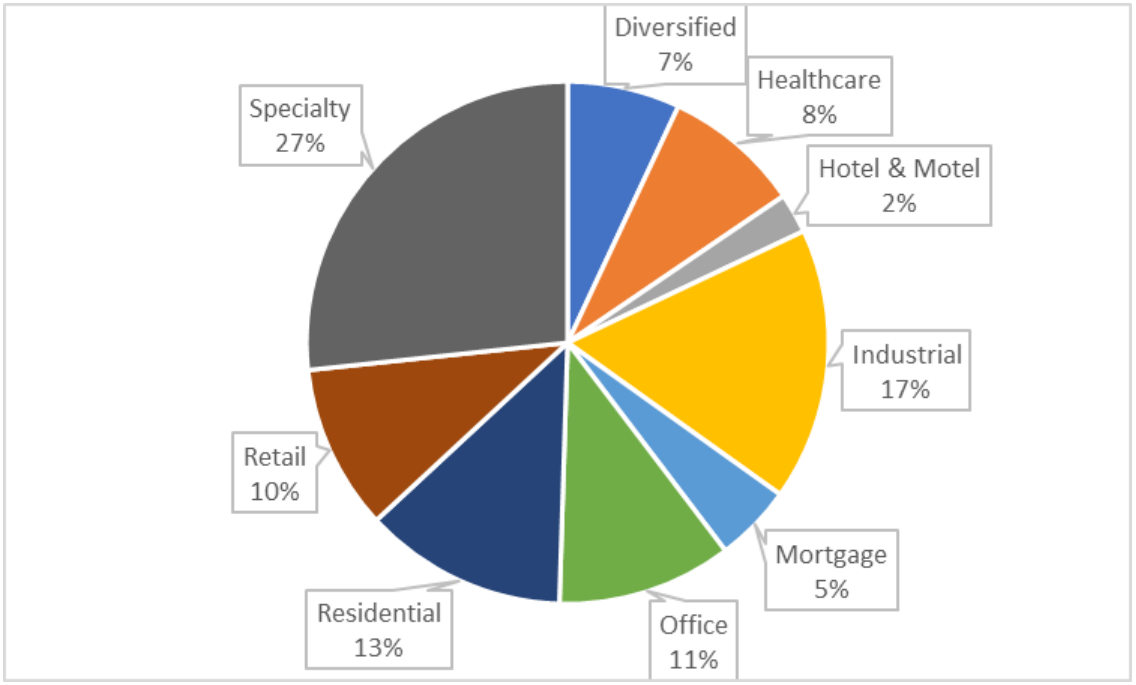

Figure 2: Distribution of REITs across different industries on 31-12-2020 *(N=193)*

By grouping the REITs according to their industry, the industry-specific return is calculated as the aggregate of weighted returns per industry. During the 2020 pandemic, industrial REITs are the best performers with an annual return of 11.0%. The worst performing sector during the 2020 pandemic was the retail industry, with an annual return of -29.1%. What stands out is that bad performing industries during the 2020 market shock were already performing badly in 2019. On the contrary, the good performers of 2019 continued to perform relatively well during the 2020 market shock. This phenomenon might be explained by the fact that certain trends and developments that were already underway, were only accelerated by the 2020 market crash. Retail for example was already suffering from the upcoming trends in e-commerce in 2019, and the 2020 pandemic solely acted as a catalyst for this trend to accelerate. This e-commerce trend also explains why Prologis is the second best performing REITs among the large caps, and the 19th best performing REIT of the entire 2020 sample. Since Prologis facilitates distribution warehousing for e-commerce, they likely profited from this trend. The bad performance of mortgage REITs can be linked to interest rates that were already relatively low and in a decreasing trend before 2019. The income derived from lending mortgage loans is therefore low. During the first quarter of 2020, the Federal Reserve (US Central Bank) unexpectedly cuts interest rates to 0%

as part of an emergency stimulus package. This in turn made lending mortgages less lucrative and decreased the income for mortgage REITs even further. Again, the 2020 pandemic acted as a catalyst for an existing trend. An explanation for the high performance of the specialty sector could be the increased emphasis on wireless internet and communication technology, since a large portion of employers, students and scholars is forced to work from home.

The best performing REIT in the sample, with a 201% return in 2020, is called Power REIT. This REIT specializes in sustainability and invests into 3 industries: environmental friendly greenhouses, solar farm land and railroad properties. The high return of this REIT can be attributed to the fact that the greenhouses are licensed to cultivate medical cannabis. This infant industry is gradually being legalized in the USA and still has a lot of potential growth ahead. Therefore, Power REIT likely profited from the growth and legalization that this young industry experienced in 2020. The second and third best performers are Hannon Armstrong and Wheeler Real Estate Investment Trust, with a 2020 return of 102% and 73% respectively. The former is a sustainability REIT which invests almost exclusively into solar and wind projects and the storage of renewable energy. The latter is attributed to consumer goods-related retail; mainly non-discretionary retailers[1] like grocery stores and pharmacies which have been thriving during the 2020 pandemic.

The worst performer of the sample is CorEnergy Infrastructure Trust, with a return of -85% in 2020. This REIT is dedicated to energy and utilities infrastructure. More specifically, the assets in their portfolio relate to the storage and transmission of energy resources, like pipelines and tanks for crude oil, natural gas, diesel, CO2, propane and hydrogen. The poor performance of this REIT can be attributed to the decreased demand and volatile fuel prices in 2020. Especially during the first 2 quarters of 2020, when crude oil prices even became negative due to the sudden large drop in the demand for resources. As a consequence, the OPEC countries implemented a significant cut in the oil supply. Nevertheless, the demand for energy and utilities never fully recovered in 2020 and CorEnergy embodies this. The

[1] Retail stores selling essential consumer goods whose demand is not affected by economic downturns and therefore non-cyclical.

second and third worst performers are Pennsylvania Real Estate Investment Trust and Invesco mortgage capital, with a 2020 return of -81% and -80% respectively. The former is a retail REIT which invests into shopping malls, while the latter dedicates to residential and commercial mortgage-backed securities. Both of these securities have been severely impacted by the 2020 pandemic, which explains their poor performance.

The average REIT sample return in 2019 is 21.5% (sd 0.24), while the average return in 2020 is -17.1% (sd 0.30). The average return does not take market cap into account, which means that a small cap firm with an exceptionally small or large return has a relatively large impact on the average sample return of all REITs. Therefore, one has to adjust for market cap to prevent the average sample return from becoming skewed. By taking the aggregate of the product between the return and market cap per REIT, a weighted index can be calculated. The weighted logarithmic return of this index is 30.5% in 2019 and 2.7% in 2020. The same method applies for calculating the sample beta. Thus, the weighted beta[2] of the REIT sample is 0.80. In order to support the validity of REIT performance, one has to control for institutional ownership. The average percentage of institutional ownership for the sample equals 77.5%. This is close to the 80% institutional ownership of the S&P 500. Being a control variable, the degree of institutional ownership in the REITs is sufficient to accomplish a potential correlation between REITs and the S&P500. The sample is expected to behave according to the behavior of institutions and market forces as described in the theory section.

Depicted in table 1 are the descriptive statistics and a correlation matrix of variables %REIT, %S&P500, %PRE, %SMB and %HML. Times series data for the variables is depicted in figure 3 and a more detailed table of quarterly REIT and stock performance can be found in appendix B. Additional comparables between REITs and stocks can be found in appendix A.

[2] The beta is based on the past 5 years of historical price data

Table 1: Descriptive statistics

2019	Obs	Mean	Std. Dev.	Min	Max
%REIT	252	0.0013	0.0081	-0.0216	0.0242
%S&P500	252	0.0011	0.0079	-0.0300	0.0334
%SMB	252	-0.0002	0.0046	-0.0151	0.0141
%HML	252	-0.0004	0.0058	-0.0186	0.0307
%PRE	252	0.0002	0.0001	0.0000	0.0004
Correlations	%REIT	%S&P500	%SMB	%HML	%PRE
%REIT	1				
%S&P500	0.3417	1			
%SMB	0.0107	0.2099	1		
%HML	-0.4365	-0.1170	0.0942	1	
%PRE	-0.0778	0.0286	0.0417	0.1968	1

2020	Obs	Mean	Std. Dev.	Min	Max
%REIT	253	0.0004	0.0239	-0.1521	0.0882
%S&P500	253	0.0008	0.0211	-0.1094	0.0906
%SMB	253	0.0005	0.0088	-0.0359	0.0554
%HML	253	-0.0013	0.0162	-0.0489	0.0670
%PRE	253	0.0003	0.0002	-0.0000	0.0005
Correlations	%REIT	%S&P500	%SMB	%HML	%PRE
%REIT	1				
%S&P500	0.8770	1			
%SMB	-0.0090	0.0407	1		
%HML	0.2546	0.3033	0.2883	1	
%PRE	-0.0270	-0.0052	0.0426	0.0704	1

Notes: *Descriptive statistics and correlation matrix of the daily returns of 2019 and 2020. The table contains the following variables: weighted REIT Index, S&P500 Index, PRE, SMB and HML. The descriptive statistics are denoted as hundredths. The year 2020 has one more observation than 2019 because this is a bissextile year. What stands out are the minimum values for REITs and the S&P500, which are -15.2% and -10.9% respectively. This is exceptionally large for a daily return, considering the fact that the historic annual market return is 9.7%. On the contrary, the maximum daily return of 8.8% for REITs and 9.1% for the S&P500 can be considered exceptional as well. The maximum and minimum values are considerably less extreme in 2019. The standard deviation in 2019 is much lower as well, highlighting the exceptionally large degree of volatility in 2020. What follows from the correlation matrices is that REITs and the S&P500 have a strong correlation of 0.87 in 2020, while this correlation is only 0.34 in 2019. All other variables have a weak correlation.*

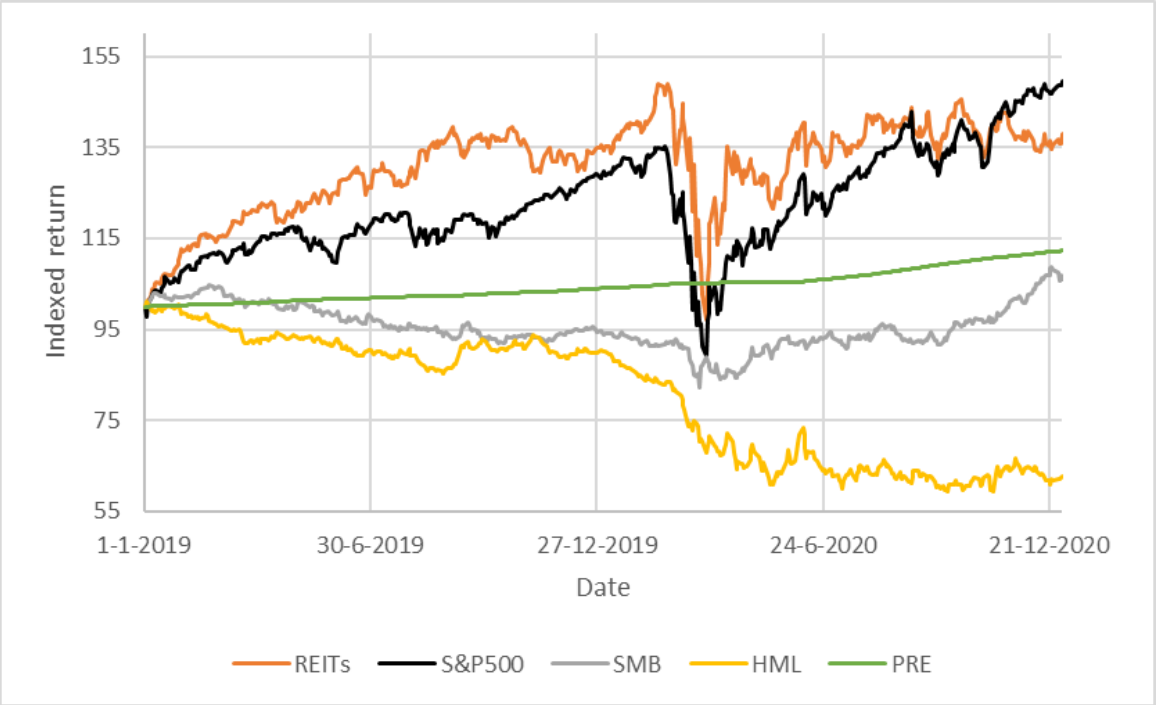

Figure 3: Time series observations

Notes: *This figure represents time series observations of the REIT Index, S&P500 Index, FMFM Index (PRE), market cap (SMB) and valuations (HML) during the sample period. The daily return observations of the 5 variables have been indexed and all thus have the same starting value of 100. Logarithmic annual returns for REITs are 30.5% in 2019 and 2,7% in 2020. Logarithmic returns for the S&P500 are 28.7% in 2019 and 15.1% in 2020. Notable is the 12.4% underperformance of REITs in 2020; nevertheless, REITs outperform stocks during the initial market shock in Q1 when volatility peaked. The return for the FMFM Index is 4.0% in 2019 and 10.9% in 2020. The SMB returns -5.3% in 2019 and 12.3% in 2020. What stands out is the poor performance (-9.6% for 2019; -30.8% for 2020) and absence of recovery for the HML. A poor performing HML suggests overvaluation for the majority of firms in the market. This overvaluation is attributed to the combination of increasing market prices with low book values. In other words: market firms experienced a loss of income and book value during the pandemic, but simultaneously experienced an increasing market cap.*

What stands out when comparing the indexed price returns of REITs and stocks in figure 3, is the relative underperformance of REITs in 2020. REITs only outperformed stocks in the first quarter, while they performed significantly worse than stocks during the other 3 quarters in 2020. Contrary to 2020, REITs outperformed stocks by in 2019. At first glance, it seems that REITs do become more connected to stocks when market shocks occur. The increase in correlation is clearly visible during the first quarter of 2020 when both variables simultaneously experience a large crash. The subsequent price recovery in Q2 of 2020 happens more or less simultaneously as well, which is in line with the existing theory. For the remaining quarters of 2020 and the entire year of 2019, REITs seem to be disconnected from stocks.

Even though they both experience substantial price appreciation without any serious shocks, they do not necessarily increase in price simultaneously during these relatively calm periods. This phenomenon could be in line with theory as well, stating that REITs are mainly connected to their underlying real estate value when market conditions are calm. In the empirical model we will test whether REIT and stock performance are positively related during the 2020 pandemic.

3.3 Vector Autoregression

Inspired by the research of Tiwari et al. (2020), a VAR will be conducted between the S&P500, REITs, SMB, HML and physical real estate. Based on the VAR, a Granger causality test, impulse response functions and forecast error variance decomposition will be computed as well. This methodology based on VAR will give insight into causality, pairwise connectedness and performance spillovers between the different variables.

The VAR will be the model of choice for the following reasons. Theory indicates that REITs, physical real estate and stocks are all part of the same economic system in which they are mutually impacting each other. This especially counts for REITs and stocks (Tiwari et al., 2020). Therefore, they affect each other reciprocally in the absence of a one-sided relationship. Thus, all variables can be considered endogenous and are a multivariate time series. The VAR is a multivariate regression model that doesn't assume exogeneity nor causality. Instead, it captures the reciprocal relationship between different variables as they change over time. The VAR is preferred over the univariate auto regression because the VAR is able to capture more features of the variables since their values do not solely depend on their own lags or white noise terms. The VAR is also preferred over traditional structural models as they are considered superior in terms of forecasting accuracy. Lastly, the data set contains daily return observations and is therefore convenient for VAR since it is already stationary data.

The VAR equation denotes a vector Y_t with t time periods:

$$Y_t = V + A_1 Y_{t-1} + A_2 Y_{t-2} + \cdots + A_h Y_{t-h} + U_t \quad (3.1)$$

Where Y_t is a stationary vector of return values in period t, V is a constant, A_h is a (n x 1) matrix of n variables that correspond to lag h, Y_{t-h} is the h^{th} lag of Y_t, and U_t is a white random vector (Brooks and Tsolacos, 2010).

The following time series variables will be implemented as Yt: %REIT, %S&P500, %SMB, %HML and %PRE.

After implementation of these variables, the VAR equation denotes:

$$\%REIT_t = V + A_1 \%S\&P500_{t-h} + A_2 \%SMB_{t-h} + A_3 \%HML_{t-h} + A_4 \%PRE_{t-h} + U_{t1} \quad (3.2)$$

$$\%S\&P500_t = V + A_5 \%REIT_{t-h} + A_6 \%SMB_{t-h} + A_7 \%HML_{t-h} + A_8 \%PRE_{t-h} + U_{t2}$$

$$\%SMB_t = V + A_9 \%S\&P500_{t-h} + A_{10} \%REIT_{t-h} + A_{11} \%HML_{t-h} + A_{12} \%PRE_{t-h} + U_{t3}$$

$$\%HML_t = V + A_{13} \%S\&P500_{t-h} + A_{14} \%SMB_{t-h} + A_{15} \%REIT_{t-h} + A_{16} \%PRE_{t-h} + U_{t4}$$

$$\%PRE_t = V + A_{17} \%S\&P500_{t-h} + A_{18} \%SMB_{t-h} + A_{19} \%HML_{t-h} + A_{20} \%REIT_{t-h} + U_{t5}$$

VAR plots the observations of one variable against the lagged observations of another variable that occur later in time. As the lag length increases in order to improve the goodness of fit, an increasing amount of degrees of freedom is lost. Each set of times series observations has a different optimal lag value that compromises between integrality and model correspondence of the observations. In order to ensure the most desired result, the optimal lag length can be determined using the Information Criteria from Akaike (AIC), Schwarz/Bayesian (SBIC) and Hannan-Quinn (HQIC). The AIC is considered the most alleviated criterium as it estimates the optimal lag value that still ensures the goodness of fit without sacrificing too much data.

Based on the results of the VAR, a forecast error variance decomposition can be computed. The FEVD determines to what extent 2 or more time series variables are impacting each other reciprocally. This variance decomposition indicates how much of each variable's variance is explained by the other variables. Thus, it relates to the magnitude of connectedness between variables; one can determine by how much one variable impacts the other, and by how much the other variables are impacting this one variable. The FEVD can be computed as a variance spillover index by rewriting the VAR equation into the following matrix format:

$$Y_t = V + \sum_{j=1}^{n} A_j Y_{t-j} + U_t \tag{3.3}$$

$$A_j = \begin{vmatrix} A_1 & \dots & A_h \\ I & \dots & 0 \\ 0 & I & 0 \end{vmatrix} \qquad Y = \begin{bmatrix} y_1 \\ \vdots \\ y_h \end{bmatrix} \quad V = \begin{bmatrix} v \\ 0 \\ \vdots \\ 0 \end{bmatrix} \quad U_t = \begin{bmatrix} u_t \\ 0 \\ \vdots \\ 0 \end{bmatrix}$$

The equation for the generalized forecast error variance is:

$$\partial_{ij}(X) = \frac{\sigma_{jj}^{-1} \sum_{x=0}^{X} ((A_h \Sigma) ij)^2}{\sum_{x=0}^{X} (A_h \Sigma A_h')_{ii}} \tag{3.4}$$

In which $\partial_{ij}(X)$ is the contribution of the jth variable to the forecast error variance of variable i with a forecast horizon X. Equation 3.5 can be simplified into the following equation:

$$\emptyset_{ij}(X) = \frac{\partial_{ij}(X)}{\sum_{j=1}^{n} \partial_{ij}(X)^2} \tag{3.5}$$

In which $\emptyset_{ij}$ (X) is the pairwise connectedness from the j^{th} variable to the i^{th} variable in the with forecast horizon X (Tiwari et al., 2020). As an alternative for manual computation and for the purpose of simplicity, the estimation platform of Gabauer (2021) can be applied.

The exact impact the variables have on each other can be further explored by computing a Granger causality test and impulse response functions (IRF). The Granger causality test predicts whether or not variables have causal impact on each other. This test has the advantage over other causality tests that it is both explanatory and confirmatory. The Granger causation is based on the concept of temporal precedence, in which the marginal impact of a newly added time series on the dependent variable is considered. The IRF is especially useful in analyzing observations over time. It has the advantage that it can predict a variable's impact over a longer period than the lag length.

4. RESULTS

4.1 Time series tests

The following time series tests are performed. In order to avoid a spurious regression, the data has to be tested for stationarity. As the data set is rather large, the Augmented Dickey-Fuller unit root test is the test model of choice (Brooks and Tsolacos, 2010). This test determines whether the variance, covariance and auto variances of the variables are constant. If this is the case for each given lag, the data is stationary. Table 2 presents the results of the Dickey-Fuller unit root test with a lag value of 1. All 5 variables have a T-statistic smaller than the critical value (1%). Therefore, the results provide significant evidence to reject the H0 hypothesis and the observations can be considered stationary.

Table 2: Augmented Dickey-Fuller unit root test

	%REIT	%SP500	%SMB	%HML	%PRE
T-Statistic	-9.261	-11.301	-11.594	-13.631	-13.450

Notes: *Results of the Dickey-Fuller unit root test with a lag value of 1. The critical values are -3.457 (1%), -2.878 (5%) and -2.570 (10%). All 5 T-statistics have a lower value than all the critical values. This provides significant evidence at a 1% level that the data is stationary.*

After calculating the IC values for the sample, the SBIC and HQIC both suggest a lag value of 1 which corresponds to 199 observations. The AIC suggests a lag value of 2 which corresponds to 146 observations. As the AIC does not take sample size directly into account, this criterium is preferred over the SBIC and HQIC and a lag of 2 is implemented. The results of the information criteria testing are presented in table 3.

Table 3: Information Criteria Testing

Lag Length	AIC	SBIC	HQIC
1	-43.61	-42.9969	-43.3609
2	-43.6528	-42.5288	-43.1961
3	-43.0655	-40.9010	-42.1912

Notes: *Results of the Information Criteria testing. The minimum criterium value corresponds to the most optimal lag length. The SBIC and HQIC both suggest an optimal lag of 1, while AIC suggests an optimal lag of 2.*

To further explore the relationship between the variables, it is necessary to test for causation using the block F-test. The block F-test determines whether or not 2 or more variables have a jointly significant impact on the dependent variable. Thus, the F-test estimates if the group of variables consisting of the returns of PRE, HML, SMB and S&P500 has a jointly significant effect on REIT returns. After conducting a linear regression, the F-statistic is significant and equals 209.38. Thus, the variables Return PRE, Return HML, Return SMB and Return S&P500 have a jointly significant effect on the Return REIT variable.

4.2 VAR model results

First, a simple VAR is considered that only contains the %S&P500 and %REIT variables. According to the VAR model depicted in table 4, a significant equation is found for the second lag of the S&P500 on REITs. All other equations are insignificant at a 5% level (except for %S&P500 against the lagged values of itself, which is to be expected).

Table 4: T-statistics of the basic VAR

Variable	%REIT	%SP500
R-squared	0.0981	0.0999
%REIT (-1)	0.101	0.212
%REIT (-2)	0.478	0.567
%SP500 (-1)	0.108	0.036
%SP500 (-2)	0.034	0.098
Constant	0.687	0.850

Notes: *T-statistics of the 2 basic variables %REIT and %S&P500 against their lagged values. A significant equation at a 5% level is found for the variable %REIT against %S&P50. All other equations are insignificant at a 5% level besides for %S&P500 against the lagged observations of itself.*

When considering the more elaborate model that contains all the variables (table 5), a significant equation is found for the first lag of both the S&P500 and the HML on REITs. The SMB and PRE variable have an insignificant equation on REITs. The SMB (second lag) and the HML (first lag) have a significant impact on the S&P500 variable. The PRE and REIT variable don't have a significant equation on the S&P500. The second lags of both the S&P500 and REIT variable have a significant equation on the PRE variable. The SMB and HML don't have a significant equation on PRE. All other equations are insignificant at a 5% level (except for the lagged values of the same variable, which is to be expected).

Table 5: T-statistics of the more elaborate VAR

Variable	%REIT	%S&P500	%SMB	%HML	%PRE
R-squared	0.2146	0.1759	0.1604	0.0923	0.9967
%REIT (-1)	0.058	0.110	0.062	0.457	0.819
%REIT (-2)	0.464	0.630	0.050	0.840	0.030
%SP500 (-1)	0.014	0.004	0.101	0.195	0.981
%SP500 (-2)	0.069	0.188	0.602	0.577	0.045
%SMB (-1)	0.150	0.722	0.040	0.075	0.177
%SMB (-2)	0.062	0.018	0.462	0.858	0.167
%HML (-1)	0.000	0.022	0.694	0.047	0.996
%HML (-2)	0.931	0.995	0.849	0.240	0.924
%PRE (-1)	0.386	0.489	0.102	0.102	0.000
%PRE (-2)	0.404	0.480	0.096	0.087	0.874
Constant	0.395	0.850	0.321	0.038	0.567

Notes: *T-statistics of the variables against their lagged values. Significant equations at a 5% level are found for the variable %REIT against %S&P500 and %HML, %S&P500 against %SMB and %HML, %PRE against %S&P500 and %REIT. The %HML variable has a significant constant equation, which implies omitted variables. All other equations are insignificant at a 5% level besides for variable equations against the lagged observations of themselves.*

4.3 Granger Causality Test and Impulse Response Functions

In order to examine causality, a Granger's causality test identifies the direction of causality between the variables, while the IRF reflect the progress of the causal impact over time. As depicted in table 6, the Granger Causality test provides no significant evidence for a mutual causal relationship between REITs and physical real estate. However, at a 10% significance level, a casual impact of REITs on PRE is found. The test provides significant evidence for a causal relationship of the S&P500 on REITs. Significant evidence is found for a causal impact of both the SMB and HML on REITs. Additionally, significant evidence is found for a causal impact of both the SMB and HML on the S&P500, although the HML is only significant at a 10% level. All other Granger causality tests are insignificant at a 10% level, which implies the following: PRE does not causally impact REITs; REITs and PRE do not

causally impact the S&P500; the S&P500, HML and PRE do not causally impact the SMB; REITs, the S&P500 and SMB do not causally impact the HML; and lastly, the S&P500 and HML do not causally impact PRE.

Table 6: Granger Causality Test

Equation	Excluded	chi2	df	Prob > chi2
%REIT	%SP500	10.489	2	0.005
%REIT	%SMB	77.677	2	0.021
%REIT	%HML	15.277	2	0.000
%REIT	%PRE	13.984	2	0.497
%REIT	ALL	30.690	8	0.000
%SP500	%REIT	30.101	2	0.222
%SP500	%SMB	67.397	2	0.034
%SP500	%HML	54.008	2	0.067
%SP500	%PRE	0.615	2	0.735
%SP500	ALL	15.683	8	0.047
%SMB	%REIT	83.146	2	0.016
%SMB	%SP500	31.844	2	0.203
%SMB	%HML	0.218	2	0.897
%SMB	%PRE	33.907	2	0.184
%SMB	ALL	19.897	8	0.011
%HML	%REIT	0.637	2	0.727
%HML	%SP500	21.708	2	0.338
%HML	%SMB	36.972	2	0.157
%HML	%PRE	64.298	2	0.040
%HML	ALL	13.545	8	0.094
%PRE	%REIT	46.841	2	0.096
%PRE	%SP500	40.828	2	0.130
%PRE	%SMB	52.428	2	0.073
%PRE	%HML	0.009	2	0.995
%PRE	ALL	10.509	8	0.231

Notes: *Results of the Granger causality test. What stands out is that %SP500, %SMB and %HML all have a significant causal impact on REIT returns, while %PRE does not have a significant causal impact on REIT returns.*

Using VAR, an IRF can be computed using these 3 causal variables (figure 4). The IRF considers an unexpected exogenous shock, and indicates what is the impact of an upward one-unit change in the

"impulse" variable on the "response" variable. Figure 4 depicts the impact of one of the 3 causal impulse variables (%S&P500, %SMB, %HML) on the response variable (%REIT) over time.

What follows from the IRF is that during an exogenous market shock, the %S&P500 and %SMB initially approximate circumstances inflicting a negative response in REIT returns. This initial negative response is followed by a recovery and positive response. Initially, a 1% increase in the S&P500 results in a 0.3% decrease in REIT returns. However, at period 2, this turns into an increase of 0.2%. Eventually, the positive and negative responses seem to cancel each other out. About the same IRF holds for the %SMB variable. The %HML and %REITs appear to increase or decrease simultaneously. A 1% increase in the

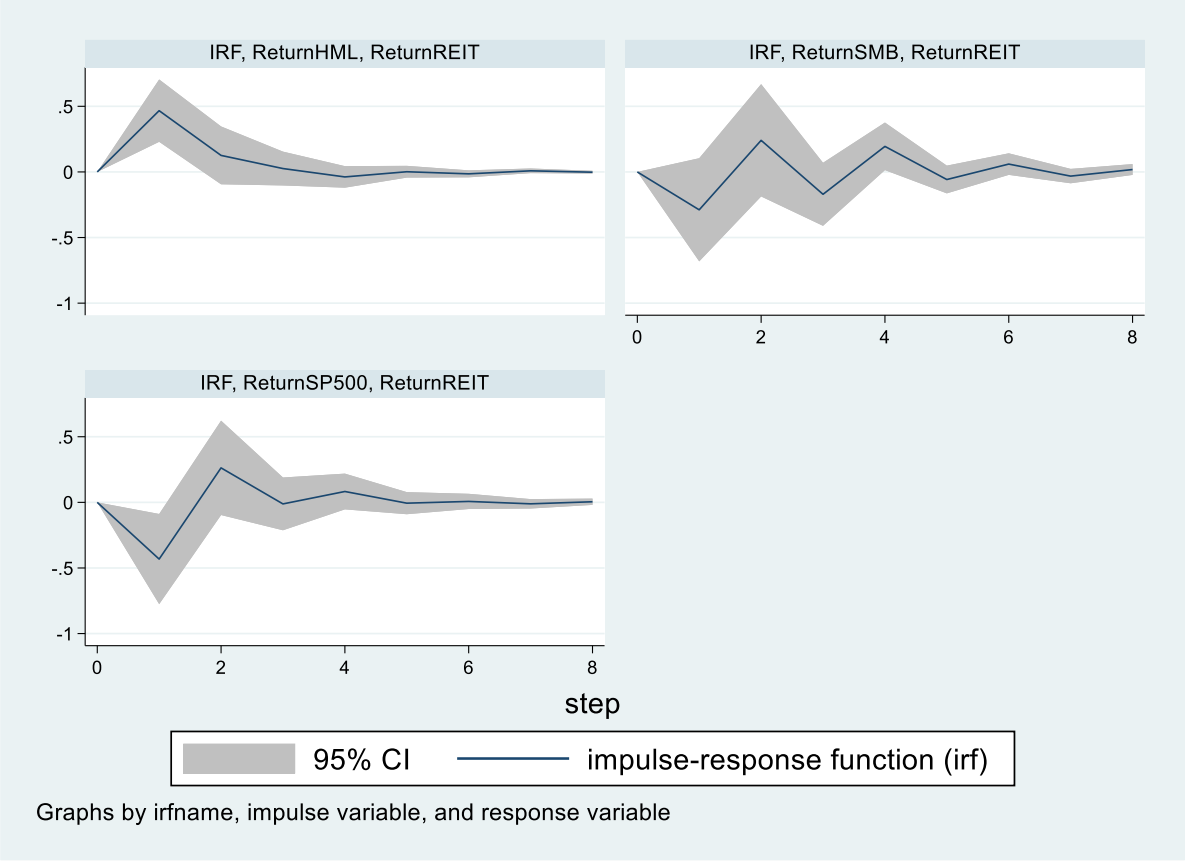

Figure 4: Impulse response function of the %SP500, %HML and %SMB and on the %REIT variable

%HML variable results in a maximum 0.4% increase in REIT returns. After this initial response, the impact gradually fades off with time while remaining positive.

If the significant VAR equations are combined with the significant tests for Granger causality and IRF, the following relationships arise; The results suggest that the S&P500 and valuations (HML) have a significant and causal impact on REITs during the 2020 pandemic. Physical Real Estate does not have a significant causal impact on REIT performance. This significant causality implies that a change in both the market valuations and the S&P500 is able to cause and effect changes in REIT performance. On the contrary, a change in physical real estate is not able to cause and effect changes in REIT performance.

4.4 Forecast Error Variance Decomposition

According to the FEVD (table 7), variance spillovers between REITs and stocks are much stronger than spillovers between REITs and physical real estate. REITs and the S&P500 exchange the most performance spillovers witch each other, as they both explain around 33% of each other's forecast error variance. The %SMB and %HML variables explain 3.5% and 19.2% of REIT returns respectively. Physical Real Estate seems to have a small impact on the S&P500 and REITs, explaining 4.7% and 3.0% of their forecast error variance respectively. Vice versa, the S&P500 explains 4.2% and REITs explain 3.4% of the forecast error variance in physical real estate. When considering net spillovers, the S&P500 emits 8.7% more than it receives, and is therefore the main source of net spillovers in this model. The valuations variable (%HML) is with -6.4% the largest receiver of net spillovers in the model. REITs have net spillovers of 2.4%, and therefore emit more spillovers than they receive. Hence, almost all of the net spillovers that REITs receive originate in stocks.

Physical real estate has net spillovers of 0.5%, indicating that this asset class neither receives nor transmits significant performance spillovers. Both the %PRE and %SMB are largely disconnected from the model, as they explain most of their variance by themselves (87.2% and 85.9% respectively). The total spillovers are about 35.4%. Thus, spillovers between %S&P500, %REIT, %SMB, %HML and %PRE account for 35.4% of the total forecast error variance in this model. This suggests that there might be omitted variables. The large impact of %HML compared to %SMB indicates that the marginal impact

of undervaluation on performance is larger than the marginal impact of market size on performance. This suggests that it is more feasible to increase returns if companies focus on attaining high book-to-market value's instead of firm growth. In addition, the %HML variable could have a large impact due to 90% dividend distribution of REITs. As previously discussed by Fama and French, the market pricing of REITs occurs efficiently and based on intrinsic values. Therefore, valuations have a relatively large impact on performance.

As depicted in the spillover graphs in figure 5; stocks were mainly impacted by REIT spillovers untill September 2020. In the last 4 months of the year, the trend reversed and net spillovers flowed from stocks to REITs. Physical real estate received a sudden peak in spillovers from both REITs and stocks in the last month of 2020.

Table 7: FEVD

	%REIT	%S&P500	%PRE	%SMB	%HML	FROM others
%REIT	44.48	33.73	3.39	2.35	16.05	55.52
%S&P500	32.25	47.19	4.15	3.09	13.31	52.81
%PRE	3.01	4.74	87.17	1.56	3.51	12.83
%SMB	3.45	6.65	1.59	85.90	2.42	14.10
%HML	19.17	16.41	4.21	1.84	58.37	41.63
TO others	57.89	61.52	13.35	8.85	35.29	176.89
To others Inc. own	102.37	108.72	100.52	94.74	93.65	
NET spillovers	**2.37**	**8.72**	**0.52**	**-5.26**	**-6.35**	**35.38**

Notes: *Variance spillovers between the 5 different variables. %REIT and %S&P500 exchange the most spillovers with each other. The %HML variable has a large impact on %REIT and %S&P500. The %PRE and %SMB variables are largely disconnected from the model and solely impact other variables to a small extent. This indicates that valuations have a larger effect on performance than market cap.*

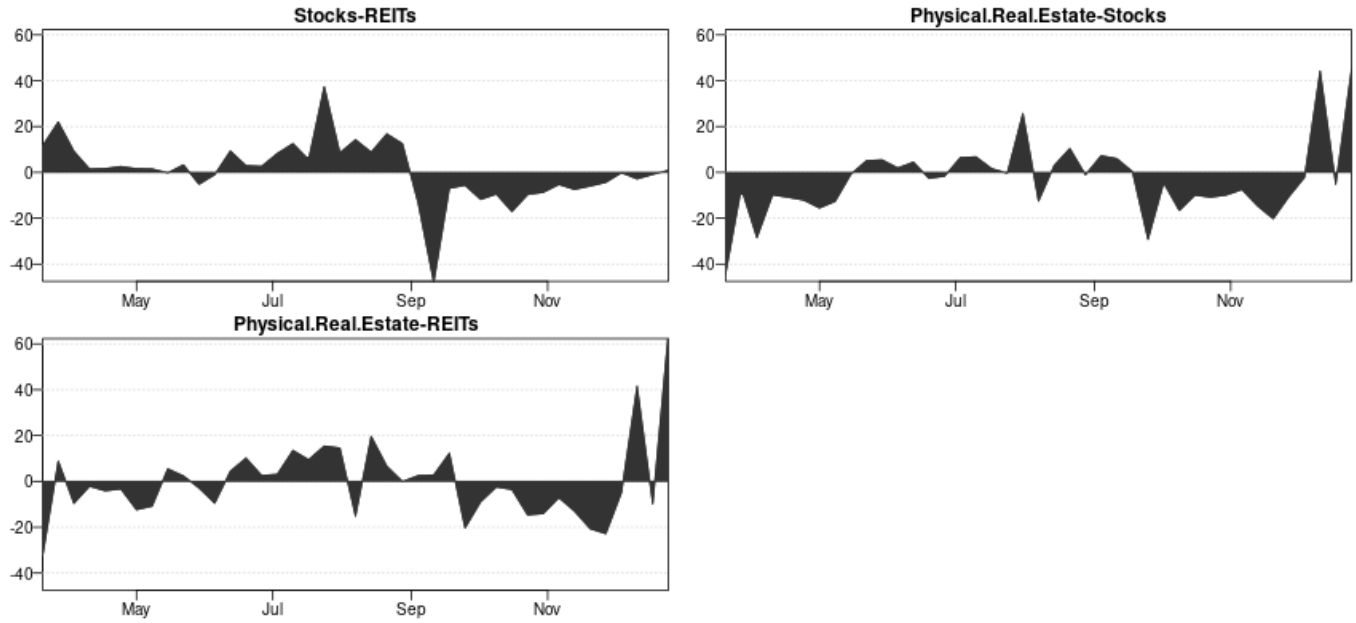

Figure 5: Spillovers graphs of the %SP500, %REIT and %PRE variables.

5. DISCUSSION

The results of the VAR, Granger Causality test, IRF and FEVD are in line with existing theory, arguing that REITs disconnect from their underlying real estate when a market shock occurs (Boudry et al., 2012). This is attributed to the fact that a market shock is a financial factor. Physical real estate is less likely affected by financial factors, unlike REITs and stocks. Instead, physical real estate is more sensitive to macro-economic factors, like inflation and interest rates (Liu et al., 2012). Therefore, physical real estate remains unaffected, while REITs are affected and therefore disconnect. Hence, REIT performance is significantly impacted by the stock market during the 2020 pandemic and not by physical real estate. Also, a significant impact for both the SMB and HML on the S&P500 is found. This is consistent with the existing theory of Fama and French who argue that market cap (SMB) and market valuations (HML) are related to stock performance. As the SMB and HML are both proxy's for market risk, a change in these variables results in a change in the stock performance since investors demand an adjusted risk premium.

The motivation for this research is to measure diversification benefits and performance of REITs relative to the stock market during the 2020 pandemic. Based on the results, we find that REITs provide limited diversification benefits during the 2020 pandemic. This implicates that investors cannot fully rely on REITs for portfolio diversification during abnormal market circumstances induced by a pandemic. This potentially holds for revivals of the Covid-19 pandemic in the future, as well as for other future pandemics and/or similar-magnitude events.

This research opposes the following limitations. First, the Fannie Mae and Freddie Mac Price Index is not a completely comprehensive proxy for physical real estate. It only accounts for residential real estate. Thus, other real estate industries are omitted. Therefore, future research should create and include a more comprehensive proxy for physical real estate that includes other subtypes, like commercial real estate for example.

Second, the VAR suggests confounding variables that are not included in the model. Especially concerning the physical real estate variable, confounding third variables are likely the case. Reciprocal spillovers between physical real estate and stocks are more evident than reciprocal spillovers between REITs and physical real estate. Therefore, not only are REITs more evidently connected to stocks, but physical real estate is more evidently connected to stocks as well than it is to REITs. This can be attributed to the fact that the stock market represents a good proxy for the state of the overall economy, and developments concerning the latter are being reflected into real estate as well. Even though physical real estate is not affected by financial factors like REITs and stocks, it is sensitive to macro-economic factors. On the contrary, REITs are more likely to be affected by financial factors. Because REITs are related to the stock market, they can be considered as an independent exchange traded financial instrument instead of a real estate derivative. Therefore, new information is rapidly reflected into REIT valuations compared to physical real estate valuations. Economic factors, like unemployment or inflation, have limited impact on REIT performance (Liu, Loudon and Milunovich, 2012). Therefore, financial factors are more significant and explanatory than economic factors in the case of REITs. Since this research is focused on REITs instead of physical real estate, macro-economic variables are not

included. As a suggestion for future research, it is recommended to include macro-economic variables like inflation and interest rates in addition to financial factors. By including these omitted factors, the model will be more comprehensive. Especially the specific impact and relation of physical real estate with the other variables in the model becomes increasingly extensive.

6. CONCLUSION

Based on the VAR, the Granger causality test implies that market size, valuations and the S&P500 have a causal impact on REIT returns. Additionally, market size and valuations have a causal impact on S&P500 returns, which is to be expected according to Fama and French. All other variables are insignificant, including physical real estate which represents the underlying value of REITs. Subjecting these 3 causal variables to the IRF gives the following results: Initially, a 1% increase in the S&P500 results in a 0,4% decrease in REIT returns. However, at period 2, this turns into an increase of 0,2%. Eventually, the positive and negative responses seem to cancel each other out. About the same holds for the SMB variable. The HML variable indicates that REITs and valuation tend to increase/decrease simultaneously.

A FEVD is performed to determine the exact magnitude of this impact by indicating how much of each variable's variance is explained by the other variables. The S&P500 is the largest source of spillovers in the model as it emits 8.7% more variance than it receives, while valuations receives the most spillovers (6,35%). Besides REITs explaining their own performance for 45%, the S&P500 explains the largest portion of REIT returns with 32%, while the underlying real estate only explains 3% of REIT returns. Additionally, physical real estate is largely disconnected from the model as only 13% of its performance is explained by other variables. This in line with existing theory, stating that physical real estate disconnects from the stock market and is not affected by financial factors. This conclusion allows us to answer the central research question:

How did the stock market affect REIT performance during the 2020 market shock?

This research provides significant evidence that REIT performance is impacted by the stock market during the 2020 pandemic and that REITs disconnect from their underlying real estate in terms of performance. As a consequence, REITs provide limited diversification benefits during the 2020 pandemic.

REFERENCES

An, H., Wu, Q. and Wu, Z. (2016). 'REIT crash risk and institutional investors'. *The Journal of Real Estate Finance and Economics*, 53(4), pp. 527-558.

Beasley, G. (2020). 'Real Estate Offers A Powerful Hedge Against Market Volatility'. *Forbes*, 2 January. Available at: https://www.forbes.com/sites/forbesrealestatecouncil/2020/01/02/real-estate-offers-a-powerful-hedge-against-market-volatility/?sh=57f2f0a17bad (Accessed: 1-3-2021).

Berk, J., DeMarzo, P. and Harford, J. (2019). *Fundamentals of Corporate Finance: Global Edition, Fourth Edition.* London: Pearson Education.

Block, R. L. (2011). *Investing in REITs: Real Estate Investment Trusts*. Hoboken, NJ: John Wiley & Sons.

Boudry, W. I., Coulson, N. E., Kallberg, J. G. and Liu, C. H. (2012). 'On the hybrid nature of REITs'. *The Journal of Real Estate Finance and Economics*, 44(1), pp. 230-249.

Brooks, C. and Tsolacos, S. (2010). *Real Estate Modelling and Forecasting*. Cambridge: Cambridge University Press.

Chiang, M. C., Tsai, I. C. and Sing, T. F. (2010). 'Are REITs a good shelter from financial crises? Evidence from the Asian markets'. *Journal of Property Investment & Finance*, 31(3), pp. 237-253.

Das, P. K., Freybote, J., and Marcato, G. (2015). 'An investigation into sentiment-induced institutional trading behavior and asset pricing in the REIT market'. *The Journal of Real Estate Finance and Economics*, 51(2), pp. 160-189

Edwards, T. M. (2016). 'Global REIT Survey 2016'. *European Public Real Estate Association*. Available at: https://www.epra.com/media/US_REIT_Survey_1473930302925.pdf (Accessed 31-8-2021).

Fama, E. F. and French, K. R. (1992). 'The Cross-Section of Expected Stock Returns'. *The Journal of Finance*. 47(2), pp. 427-465.

Fama, E. F. and French, K. R. (1993). 'Common risk factors in the returns on stocks and bonds'. *Journal of Financial Economics*. 33(1): pp. 3–56.

Fama, E. F. and French, K. R. (1998). 'Taxes, financing decisions, and firm value'. *The Journal of Finance*, 53(3), pp. 819-843.

Frankel, M. (2020). 'REIT Statistics: Everything to Know About REITs in 2020'. *Millionacres*, 12 April. Available at: https://www.millionacres.com/research/reit-statistics/ (Accessed: 16-5-2021).

French, K. R. (2021). 'Current Research Returns'. *Dartmouth*. Available at: Kenneth R. French - Data Library (dartmouth.edu) (Accessed 7-7-2021).

Gabauer, D. (2021). 'Online Estimation Platform'. *Econometric Code*. Available at: David Gabauer - Econometric Code (google.com) (Accessed: 24-8-2021).

Getry, W. M., Kemsley, D. and Mayer, C. J. (2003). "Dividend taxes and share prices: evidence from real estate investment trusts". *The Journal of Finance*, 58(1), pp. 261-282.

Gore, R. and Stott, D. M. (1998). 'Toward a more informative measure of operating performance in the REIT industry: net income vs. funds from operations'. *Accounting Horizons*, 12(4), pp. 323–339.

Granite REIT (2021). 'Granite REIT – Portfolio Overview'. *Granite REIT Inc.* Available at: https://granitereit.com/wp-content/uploads/2021/05/Property-Statistics-Q1-2021.pdf (Accessed: 16-5-2021).

Hoesli, M. and Oikarinen, E. (2012). 'Are REITs real estate? Evidence from international sector level data'. *Journal of International Money and Finance*, 31(7), pp. 1823-1850.

Jain, P. and Upadhyay, A. (2021). 'Are REITs More Resilient than non-REITs? Evidence from Natural Experiments'. *Japan and the World Economy*, 58(1), pp. 101069.

Liu, J., Loudon, G. and Milunovich, G. (2012). 'Linkages between international REITs: the Role of Economic Factors'. *Journal of Property Investment & Finance*, 30(5), pp. 473-492.

NASDAQ, (2021). 'Indexes.' *NASDAQ*. Available at: https://www.nasdaq.com/ (Accessed 8-10-2021).

Ott, S. H., Riddiough, T. J. and Yi, H. C. (2005). 'Finance, investment and investment performance: Evidence from the REIT sector'. *Real Estate Economics*, 33(1), pp. 203-235.

Simon, S., and Ng, W. L. (2009). 'The effect of the real estate downturn on the link between REITs and the stock market'. *Journal of Real Estate Portfolio Management*, 15(3), pp. 211-219.

S&PGlobal, (2021). 'S&P500 Overview'. *S&PGlobal.* Available at: https://www.spglobal.com/spdji/en/indices/equity/sp-500/#overview (Accessed 8-10-2021).

Subrahmanyam, A. (2007). 'Liquidity, return and order-flow linkages between REITs and the stock market'. *Real Estate Economics*, 35(3), pp. 383-408.

Tiwari, A. K., André, C., and Gupta, R. (2020). 'Spillovers between US real estate and financial assets in time and frequency domains'. *Journal of Property Investment and Finance*, 38(6), pp. 525-537.

Tradingview, (2021). 'First TR ftse EPRA/NAREIT DEVL COM NPV 1D Cboe BZX'. *Tradingview.* Available at: https://www.tradingview.com/chart/pIzsU2ap/ (Accessed: 2-3-2021).

Wu, M. C., Liau, Y. S., and Wang, Y. C. (2020). 'Are there contagion effects in the REIT market? The case of Brexit'. *Economic Research-Ekonomska Istraživanja*, 58(1), pp. 1-17.

Zhao, Y., Zakharova, D. V. and Zettelmeyer, J. (2020). 'US Housing Market during COVID-19: Aggregate and Distributional Evidence'. *IMF Working Papers*, 212, A001.

Zhou, X. and Ziobrowski, A. J. (2009). 'An investigation into REIT performance persistency'. *Journal of Property Research*, 26(2), pp. 149-170.

APPENDIX

A. Comparables REITs and Stocks (31-12-2020)

Index Characteristics	Weighted REIT Index	S&P500 Index
Number of constituents	193	500
Market Capitalization	$1,421 billion	$35,385 billion
% Held by institutions	77.5%	80.0%
Top 10 constituents in % market cap	39.7%	27.2%
Top 10 Largest Constituents		
1	American Tower Corp	Apple Inc
2	Prologis	Microsoft Corp
3	Crown Castle Corp	Amazon.com Inc
4	Equinix Inc	Facebook Inc
5	Public Storage	Alphabet Inc Class A
6	Digital Realty Trust	Alphabet Inc Class C
7	Simon Property Group	Tesla Inc
8	SBA Communications	Berkshire Hathaway Inc Class B
9	Welltower Inc	JP Morgan Chase & Co
10	Weyerhaeuser	Johnson & Johnson

B. Quarterly Performance of REITs and Stocks

	REIT price performance	Stock price performance	REIT outperformance
2019 (log)	**30.51%**	**28.70%**	**1.81%**
Q4	0.06%	9.31%	-9.26%
Q3	8.26%	0.37%	7.89%
Q2	4.29%	2.48%	1.81%
Q1	19.33%	12.14%	7.19%
2020 (log)	**2.68%**	**15.10%**	**-12.42%**
Q4	-1.16%	10.37%	-11.53%
Q3	-0.45%	7.56%	-8.01%
Q2	16.69%	22.53%	-5.84%
Q1	-11.08%	-23.14%	12.06%

C. Alphabetical sample list including ticker symbol

1. AAIC Arlington Asset Investment Corp
2. AAT American Assets Trust, Inc
3. ABR Arbor Realty Trust Inc
4. ACC American Campus Communities, Inc.
5. ACR Acres Commercial Realty Corp
6. ACRE Ares Commercial Real Estate Corp
7. ADC Agree Realty Corporation
8. AFIN American Finance Trust Inc Class A
9. AGNC AGNC Investment Corp
10. AIV Apartment Investment and Management Co
11. AJX Great Ajax Corp
12. AKR Acadia Realty Trust
13. ALEX Alexander & Baldwin Inc (Hawaii)
14. ALX Alexander's, Inc.
15. AMH American Homes 4 Rent Class A
16. AMT American Tower Corp
17. APLE Apple Hospitality REIT Inc
18. APTS Preferred Apartment Communities Inc.
19. ARE Alexandria Real Estate Equities Inc
20. ARI Apollo Commercial Real Est. Finance Inc
21. ARR ARMOUR Residential REIT, Inc.
22. AVB AvalonBay Communities Inc
23. BDN Brandywine Realty Trust
24. BFS Saul Centers Inc
25. BHR Braemar Hotels & Resorts
26. BPYU Brookfield Property Reit Inc Class A
27. BRG Bluerock Residential Growth REIT Inc Class A
28. BRMK Broadmark Realty Capital Inc
29. BRT BRT Apartments Corp
30. BRX Brixmor Property Group Inc
31. BXMT Blackstone Mortgage Trust Inc
32. BXP Boston Properties, Inc.

33. CCI Crown Castle International Corp
34. CDOR Condor Hospitality Trust Inc
35. CDR Cedar Realty Trust Inc
36. CHCT Community Healthcare Trust Inc
37. CHMI Cherry Hill Mortgage Investment Corp
38. CIM Chimera Investment Corporation
39. CIO City Office REIT Inc
40. CLDT Chatham Lodging Trust
41. CLI Mack Cali Realty Corp
42. CLNC Colony Credit Real Estate Inc
43. CLNY Colony Capital Inc
44. CLPR Clipper Realty Inc
45. CMCT CIM Commercial Trust Corp
46. CMO Capstead Mortgage Corporation
47. COLD AmeriCold Realty Trust
48. CONE CyrusOne Inc
49. COR CoreSite Realty Corp
50. CORR Corenergy Infrastructure Trust Inc
51. CPLG CorePoint Lodging Inc
52. CPT Camden Property Trust
53. CTRE Caretrust REIT Inc
54. CTT Catchmark Timber Trust Inc
55. CUBE CubeSmart
56. CUZ Cousins Properties Inc
57. CXP Corporate Express common stock
58. CXW Corecivic Inc
59. DEA Easterly Government Properties Inc
60. DEI Douglas Emmett, Inc.
61. DHC Diversified Healthcare Trust
62. DLR Digital Realty Trust, Inc.
63. DOC Physicians Realty Trust
64. DRE Duke Realty Corp
65. DRH DiamondRock Hospitality Company
66. DX Dynex Capital Inc
67. EGP Eastgroup Properties Inc
68. ELS Equity Lifestyle Properties, Inc.

69. EPR EPR Properties
70. EPRT Essential Properties Realty Trust Inc
71. EQC Equity Commonwealth
72. EQIX Equinix Inc
73. EQR Equity Residential
74. ESRT Empire State Realty Trust Inc
75. ESS Essex Property Trust Inc
76. EXR Extra Space Storage, Inc.
77. FCPT Four Corners Property Trust Inc
78. FPI Farmland Partners Inc
79. FR First Industrial Realty Trust, Inc.
80. FRT Federal Realty Investment Trust
81. FSP Franklin Street Properties Corp.
82. GEO The GEO Group Inc
83. GLPI Gaming and Leisure Properties Inc
84. GMRE Global Medical REIT Inc
85. GNL Global Net Lease Inc
86. GOOD Gladstone Commercial Corporation
87. GPMT Granite Point Mortgage Trust Inc
88. GRP.U Granite Real Estate Investment Trust
89. HASI Hannon Armstrong Sustnbl Infrstr Cap Inc
90. HHC Howard Hughes Corp
91. HIW Highwoods Properties Inc
92. HR Healthcare Realty Trust Inc
93. HST Host Hotels and Resorts Inc
94. HT Hersha Hospitality Trust
95. HTA Healthcare Trust Of America Inc
96. ILPT Industrial Logistics Properties Trust
97. IMH IMPAC Mortgage Holdings, Inc
98. INN Summit Hotel Properties Inc
99. IRM Iron Mountain Inc
100. IRT Independence Realty Trust Inc
101. IVR Invesco Mortgage Capital Inc
102. JBGS JBG SMITH Properties
103. KIM Kimco Realty Corp
104. KRC Kilroy Realty Corp

105.	KREF	KKR Real Estate Finance Trust Inc
106.	KRG	Kite Realty Group Trust
107.	LADR	Ladder Capital Corp
108.	LAMR	Lamar Advertising Co
109.	LAND	Gladstone Land Corp
110.	LOAN	Manhattan Bridge Capital Inc.
111.	LSI	Life Storage Inc
112.	LTC	LTC Properties Inc
113.	LXP	Lexington Realty Trust
114.	MAA	Mid-America Apartment Communities Inc
115.	MAC	Macerich Co
116.	MFA	MFA Financial, Inc.
117.	MGP	MGM Growth Properties LLC
118.	MNR	Monmouth R.E. Inv. Corp.
119.	MPW	Medical Properties Trust, Inc.
120.	NHI	National Health Investors Inc
121.	NLY	Annaly Capital Management, Inc.
122.	NNN	National Retail Properties, Inc.
123.	NRZ	New Residential Investment Corp
124.	NSA	National Storage Affiliates Trust
125.	NXRT	NexPoint Residential Trust Inc
126.	NYMT	New York Mortgage Trust Inc
127.	O	Realty Income Corp
128.	OFC	Corporate Office Properties Trust
129.	OHI	Omega Healthcare Investors Inc
130.	OLP	One Liberty Properties, Inc.
131.	ORC	Orchid Island Capital Inc
132.	OUT	Outfront Media Inc
133.	PCH	Potlatchdeltic Corp
134.	PEAK	Healthpeak Properties Inc
135.	PEB	Pebblebrook Hotel Trust
136.	PEI	Pennsylvania Real Estate Invt Trust
137.	PGRE	Paramount Group Inc
138.	PLD	Prologis Inc
139.	PLYM	Plymouth Industrial Reit Inc
140.	PMT	PennyMac Mortgage Investment Trust

141.	PSA	Public Storage
142.	PSB	PS Business Parks Inc
143.	PW	Power REIT
144.	QTS	QTS Realty Trust Inc Class A
145.	RC	Ready Capital Corp
146.	REG	Regency Centers Corp
147.	REXR	Rexford Industrial Realty Inc
148.	RHP	Ryman Hospitality Properties Inc
149.	RLJ	RLJ Lodging Trust
150.	RMRM	RMR Mortgage Trust
151.	ROIC	Retail Opportunity Investments Corp
152.	RPAI	Retail Properties of America Inc
153.	RPT	RPT Realty
154.	RWT	Redwood Trust, Inc.
155.	RYN	Rayonier Inc.
156.	SACH	Sachem Capital Corp
157.	SBAC	SBA Communications Corporation
158.	SBRA	Sabra Health Care REIT Inc
159.	SELF	Global Self Storage Inc
160.	SITC	Site Centers Corp
161.	SKT	Tanger Factory Outlet Centers Inc.
162.	SLG	SL Green Realty Corp
163.	SNR	New Senior Investment Group Inc
164.	SOHO	Sotherly Hotels Inc
165.	SPG	Simon Property Group Inc
166.	STAG	Stag Industrial Inc
167.	STAR	istar Inc
168.	STOR	Store Capital Corp
169.	STWD	Starwood Property Trust, Inc.
170.	SUI	Sun Communities Inc
171.	SVC	Service Properties Trust
172.	TCI	Transcontinental Realty Investors Inc
173.	TRMT	Tremont Mortgage Trust
174.	TRTX	TPG RE Finance Trust Inc
175.	TWO	Two Harbors Investment Corp
176.	UBA	Urstadt Biddle Properties Inc Class A

177. UDR UDR, Inc.
178. UHT Universal Health Realty Income Trust
179. UMH UMH Properties, Inc
180. UNIT Uniti Group Inc
181. VER Vereit Inc
182. VICI VICI Properties Inc
183. VNO Vornado Realty Trust
184. VTR Ventas, Inc.
185. WELL Welltower Inc
186. WHLR Wheeler Real Estate Investment Trust Inc
187. WMC Western Asset Mortgage Capital Corp
188. WPC WP Carey Inc
189. WPG Washington Prime Group Inc
190. WRE Washington Real Estate Investment Trust
191. WRI Weingarten Realty Investors
192. WSR Whitestone REIT
193. WY Weyerhaeuser Co