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Investigating the Long- and the Short-Run Diversification Potential of REITs for Private Investors

En studie av REITs långsiktiga och kortsiktiga diversifieringspotential för privatinvesterare

Charlotta Carlsson
Klara Granath

Supervisor: Bo Sjö

LINKÖPINGS UNIVERSITET

Linköping University
SE-581 83 Linköping, Sweden
013-28 10 00, www.liu.se

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Authors:
Charlotta Carlsson
chaca637@student.liu.se
Klara Granath
klagr171@student.liu.se

Supervisor:
Bo Sjö

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Abstract

Real estate is commonly viewed as a good diversification tool since the real estate market cycle exhibit low correlations to other asset classes. Moreover, Real Estate Investment Trusts (REITs) have become increasingly popular in the past decades since this investment form offers private investors a convenient way of diversifying stock portfolios with real estate. Some studies investigating the within-country diversification potential of REITs and stocks have been performed. These studies generally suggest poor diversification potential. Hence, we investigate the international diversification potential of REITs from Europe, Asia Pacific and the US for private investors holding European stocks from 2007 to 2019. For Europe and Asia Pacific, REIT markets with different maturity levels are included since emerging and developed REIT markets might have different characteristics affecting the diversification potential. We also examine which market leads which in terms of changes in returns. Moreover, the diversification potential of REITs may depend on the investment horizon, hence the long- and short-run perspectives for private investors are examined. The lesson learned from the Global Financial Crises and European Debt Crisis is that abnormal market conditions may change the behavior of assets on the financial markets, and significantly affect portfolio behavior. Hence, diversification potential in relation to crises is also considered. The methods employed are Johansen's cointegration, Granger non-causality and DCC-GARCH. Our findings suggest long- and short-run diversification potential of international REITs for European stocks. Cross-regional combinations of REITs and stocks generally offer better diversification potential than within-regional combinations, and emerging REIT markets are preferred over their developed counterparts due to lower conditional correlations. Moreover, changes in stock market returns lead changes in REIT market returns, indicating that stock markets react more quickly to new information on the market. Long- and short-run diversification potential still exists during the crises although increased conditional correlations suggest higher interdependence in this period. However, there is no trend of increasing conditional correlations over the whole sample, suggesting the abnormal market conditions during the financial turmoil did not permanently change the diversification potential of REITs in stock portfolios.

Key Words: REIT, Portfolio Diversification, DCC-GARCH, Johansen's Cointegration, Granger Causality

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Klara Granath

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1. Introduction

1.1. Background and problem discussion

Real estate is commonly viewed as a good diversification tool since real estate markets exhibit low correlations with other asset classes like stocks and bonds (Nareit, 2018). One way of investing in real estate is to buy shares in Real Estate Investment Trusts (REITs), a type of securitized real estate. REITs are companies that own assets associated with real estate. These trusts make their income from owning real estate, owning shares in companies associated with real estate and owning mortgages. The income flows are often guaranteed by long-term contracts, hence stable through various market conditions. REITs sell on the regular stock market (Nareit, 2018), though there are some private REIT stocks. REITs sometimes specialize in different segments of the market; mortgages, office buildings, residential buildings, healthcare and shopping malls among others. Despite differences in REIT regimes around the world, some common features characterize the nature of REITs which differs from regular investment trusts. Generally, REITs must distribute 70 to 90 percent of its operative income as dividends; in effect it can profit from taxation benefits and pays no, or a low amount of corporate tax (EPRA, 2018). Since REIT shares are sold on exchanges, they offer a convenient way to diversify financial portfolios, especially for private investors[1]. Moreover, the dividends investors get from REITs are historically strong and steady, making these trusts attractive for investors seeking diversification and high yield (Liow and Ye, 2018*b*).

In the short run, REIT shares might move quite independently from the rest of the economy (Oikarinen *et al*., 2011). For private investors with short investment horizons, this potential divergence has implications for short-run diversification. Moreover, there is empirical evidence that correlations between equities and securitized real estate decrease with increased investment horizons (Liow and Ye, 2018*b*). If REIT shares in the long run tend to diverge from the overall economy and equity markets, there are long-run diversification opportunities. Studies have found that equity REITs[2] can be considered as substitutes for direct real estate investments in the long run (Oikarinen *et al*., 2011; Yunus *et al*., 2012; Hoesli and Oikarinen, 2014). However, there are contradictions in empirical findings where other studies argue REITs to behave like stocks (Mull and Soenen, 1997; Glascock *et al*., 2000). Despite this contradiction, REITs might work as a substitute for direct real estate investments in the long run and private investors with long investment horizons can profit from the benefits of diversification by investing in REITs. This argues for including REITs in stock portfolios, with the purpose of enhancing the risk-return relationship through real estate diversification.

However, some studies show that combining REITs and stocks within a country offers poor diversification potential due to similar within-country market characteristics (Chang *et al*., 2015; Fang *et al*., 2017; Yüksel *et al*., 2017). This study investigates the diversification potential from combining international REITs with European stocks and contribute with information of the international diversification potential of REITs. Furthermore, a within-regional comparison of the diversification potential of emerging and developed REIT markets is performed. Covering the Global Financial Crisis (GFC) and European Debt Crisis (EDC) which is a period characterized by increased volatility of financial and real estate markets (Liow and Ye, 2018*b*), this study also evaluates how the characteristics of REIT markets as a diversification tool change in times of global financial turmoil. This will bring further understanding of investment strategies for private investors seeking to diversify stock portfolios with real estate.

[1] "A private investor is a person who invests money, rather than a company or financial organization that does this" (Cambridge University Press, 2019).

[2] Equity REITs have direct real estate as underlying asset while mortgage REITs own mortgages as underlying asset. These are the main types of REITs (Nickolas, 2015).

1.2. Purpose and research questions

The purpose of this thesis is to examine the long- and short-run diversification potential of combining REITs and stocks for private investors. This is of interest since real estate is widely acknowledged as a good diversification tool in stock portfolios, and REITs provide a convenient alternative for investors seeking to add real estate to their portfolios. Furthermore, we will determine which market leads which in terms of changes in returns. We will also examine whether developed and emerging REIT markets offer different diversification opportunities and whether the diversification potential of REITs changes in times of crises. This will be examined through Johansen's cointegration, Granger non-causality and DCC-GARCH modelling. Our aim is to answer the following research questions:

- In what way might REITs contribute to long- and short-run diversification for private investors?
- In what way do the diversification potential differ between developed and emerging REIT markets?
- How does the diversification potential differ with respect to crises?

1.3. Methodology

We use weekly frequency data in the form of seven European stock indices and five different REIT indices obtained from Thomson Reuters Datastream. Firstly, we examine the static relation between different pairs of REIT and stock markets through an unconditional correlation analysis. Moreover, Johansen's pairwise Cointegration is employed to determine the potential long-run diversification between these pairs. Granger's test for non-causality then examines which market is leading which in terms of asset returns. For these regressions the sample is divided into two sub-periods allowing us to examine whether the diversification potential is affected by crises in financial and real estate markets. The first period covers 2007Q3 – 2011Q4 and the second period covers 2012Q1 – 2019Q1. Furthermore, the short-run diversification potential is examined by employing a DCC-GARCH model, investigating time-varying connections between the different markets. This short-run perspective of the diversification potential is of particular interest in times of crises. Furthermore, the DCC indicate the average level of conditional correlation in the long run. Hence, it adds information to the long-run cointegration analysis by providing a measure for ranking the long-run diversification potential between different REIT-stock combinations. In the DCC modelling the whole sample is employed without dividing it into sub-samples. Our study is the first to our knowledge investigating the REIT-stock relation through a combined cointegration and DCC-GARCH approach, contributing to existing research with a comprehensive long- and short-run analysis of the diversification potential of REITs.

1.4. Delimitations

While there might be different implications of portfolio composition for institutional and private investors, this thesis takes the perspective of private investors seeking diversification opportunities. Moreover, this study examines the long- and short-run diversification opportunities from combining REITs and stocks, contributing with information on the diversification potential of REITs for private investors with long and short investment horizons.

The stock markets examined in this study are UK, Germany, France, Spain, Finland, Sweden and Denmark. These countries are developed, both in terms of stock market development and living standard (FTSE Russell, 2019; World Bank, 2019*b*). In this type of economy, private investors are likely to hold stock portfolios to gain returns on savings capital (El-Wassal, 2013). Moreover, as developed markets are affected by financial integration (Donadelli and Paradiso, 2014) and stocks from developed European countries can be expected to strongly correlate with each other (Meric *et al.*, 2015) it is likely that investors turn to other asset classes when diversifying their portfolios, where REITs provide a good alternative. While REITs become increasingly popular, the size and maturity level of REIT markets differ between countries. Among today's existing REIT markets, the US is considered as the most mature, followed by other established REIT markets such as Australia, France, Germany, UK, Hong Kong, Singapore and Japan (EY, 2018). In this study we use REIT indices from the US, Asia Pacific and Europe. These REIT markets are chosen to represent a large part of the global REIT market. Furthermore, Asia Pacific and Europe have different maturities of their REIT markets allowing us to examine whether there are different implications for diversification between emerging and developed markets within a region.

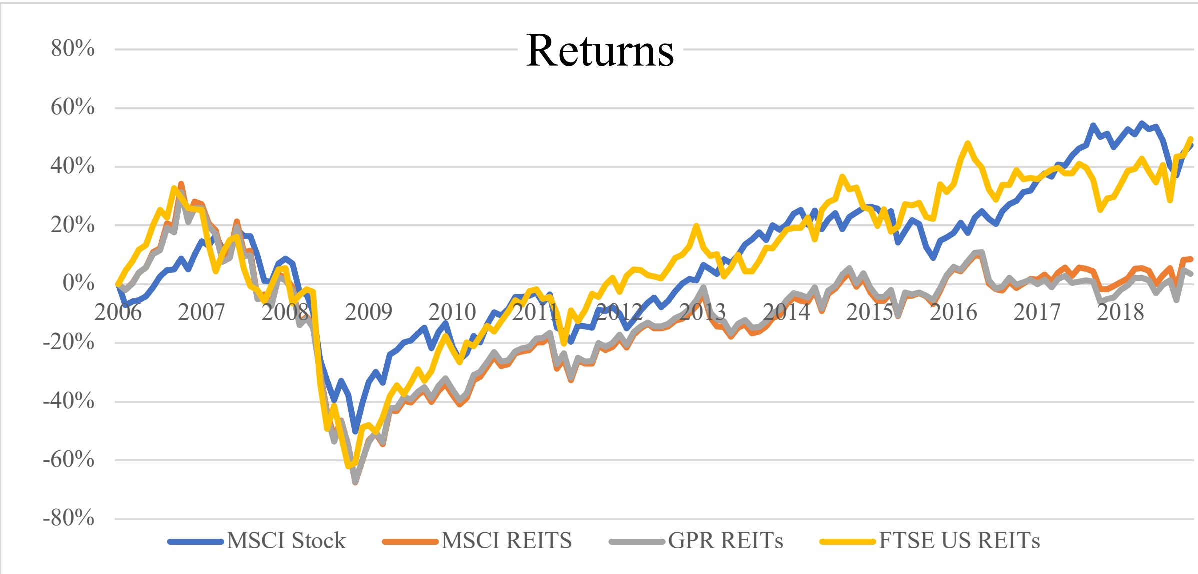
2. REITs as a diversification tool

2.1. Introduction to REITs

REITs were first introduced by the US Congress in 1960, and since then many countries have implemented REITs in their domestic markets (SEC, 2011). In June 2017 REITs represented 41 percent of the total global listed real estate market. However, the size of the REIT markets differs between developed and emerging markets, where REITs represent 51.7 percent of the total global listed real estate market in developed economies while only 7.2 percent in emerging economies. This disparity is due to structural differences in market conditions, as well as different maturity levels of the regimes (EPRA, 2017). In 2018, the total market capitalization of the 38 currently existing REIT markets was USD 1,7 trillion approximately (EY, 2018), while the market capitalization of listed domestic companies, as a proxy for the stock market, was estimated to USD 65,661 trillion in the same year (World Bank, 2019*a*).

Graph 2.1 represent returns for a global stock index, two global REIT indices and one US REIT index for the past 13 years. Returns are recalculated with the same base for easier comparison. The MSCI World Index represents large and mid-cap equity and proxies the global stock market, while MSCI World REITs Index and GPR 250 REIT Index cover the global REIT market. FTSE Nareit All Equity REITs represent the US REIT market.

Graph 2.1



Source: Own calculations. Data collected from Thomson Reuters Datastream.

As displayed in Graph 2.1, the REIT market returns generally follow a similar pattern as global stock market returns, although the stock market returns are higher. Before the GFC, the REIT markets overperformed the stock market, but after the crisis the global REIT market has not recovered as much as the stock market and is to this date underperforming it. Interestingly, a different pattern is exhibited for the US REIT market, which outperforms the stock market for the periods of mid 2006 – mid 2007, late 2011 – mid 2013, late 2014 – mid 2017. The US REIT market is the most mature in the world (EY, 2018), which may explain the stronger performance. This has interesting implications for investors, since the size and maturity of the REIT market are factors that might influence its performance. However, REITs are typically seen as long-term investments and as shown in the graph, there is a positive trend in growing returns for the past ten years for all REIT indices. Moreover, Nareit (2019) examined investment performance of FTSE Nareit All Equity REITs in relation to leading US benchmarks such as S&P500 and Nasdaq Composite. It was found that on a five-year horizon the REIT market has marginally been outperformed by the stock market. However, on longer investment horizons such as 20, 30 and 40 years the REIT market has performed better than the benchmarks which support the argument for REITs as a long-term investment.

However, in the past decades globalization has resulted in more integrated markets worldwide, implying that diversification effects might decrease as markets become more interdependent (Liow *et al.,* 2009). Moreover, the GFC caused a global economic downturn. Since then, several studies have showed increased volatility spillover effects between financial markets. The overall conclusion is that market correlations are higher in periods of high volatility (Liow and Ye, 2018*b*; Gu *et al*., 2017) implying a crisis of this magnitude can affect and even eliminate the diversification benefits of real estate. For private investors seeking diversification options, the effects of increased interdependence and financial crises on diversification are important to consider to maintain a stable portfolio risk-return relationship.

2.2. Financial integration and its implication for diversification

The importance of diversification has received greater attention in the past decades, and is nowadays an acknowledged tool for reducing risk in relation to return. Regarding diversification, the co-movements between assets are important for investors to consider, since increased co-movements imply smaller benefits of diversification.

Studies have found European financial markets to become more closely connected because of financial integration (Hardouvelis *et al*., 2006; Bley, 2009; Büttner and Hayo, 2011; Virk and Javed, 2017). Increased financial integration is explained by increasingly homogenous financial regulations worldwide, which is the case for the European Union for example (Liow and Ye, 2018*a*). Financial integration makes financial markets increasingly affected by global market risk rather than country-specific risk (Hardouvelis *et al*., 2006). Generally, greater connection between markets implies diminished diversification potential from global investments (Donadelli and Paradiso, 2014). Moreover, during financial turmoil, increased correlations and volatility spillover imply increased financial integration (Zheng and Zuo, 2013; Ahmad *et al*., 2015). Focusing on the recent GFC, the volatility tends to spill over from the US market to other markets, both for stocks (Zheng and Zuo, 2013) and securitized real estate (Liow and Ye, 2018*a*; Liow and Ye, 2018*b*). This results from economic globalization (Liow and Ye, 2018*a*) and increased business cycle synchronization (Liow and Ye, 2018*b*). However, Donadelli and Paradiso (2014) argue that emerging markets are less affected by global recessions in terms of increased integration because they do not exhibit global market characteristics. On this note, Li and Majerowska (2008) find that European emerging markets are better described by country-specific risk than global or regional risk. If financial integration does not affect emerging markets to the same extent as developed markets, the emerging markets might provide a good alternative for risk diversification for private investors.

Moreover, Hsieh (2014) find the characteristics of listed real estate companies to be more like their corresponding stock markets rather than the underlying real estate markets. Different securitized real estate markets are found to increasingly share the same market cycles, which decreases the opportunity of geographical diversification (Michayluk *et al*., 2006; Nikbakht *et al*., 2016; Liow and Ye, 2018*a*; Liow and Ye, 2018*b*). On this note, there is empirical evidence of volatility spillover between the US and European securitized real estate markets (Liow and Ye, 2018*a*; Liow and Ye, 2018*b*). Moreover, the Asian REIT markets have become increasingly connected with the US REIT market (Tsai and Lee, 2012; Chang and Chen, 2014). Increased dynamic conditional correlations between REIT markets are found during the GFC (Gu *et al*., 2017) indicating that REITs also exhibit increased interdependence during financial shocks.

In sum, financial integration decreases the potential of international risk diversification but seems to affect emerging and developed markets differently. Furthermore, financial interdependence generally increases during financial turmoil. This holds for both stock markets and securitized real estate markets, encompassing REITs. For private investors, this has implications for portfolio diversification and is important to consider when setting up or adjusting portfolios. Therefore, it is interesting to review the field of studies examining how different combinations of securitized real estate or REITs and stocks behave in terms of diversification.

2.3. The relation between REIT and stock markets

In 1993 the Omnibus Budget Reconciliation Act (OBRA) facilitated institutional investments in REITs resulting in increased demand for REITs by insurance companies, mutual funds and pension funds (Brounen and de Koning, 2012). Glascock *et al.* (2000) analyze the impact of OBRA on the relationship between the US REIT and stock markets on a sample from 1972 to 1996. Employing cointegration to examine the long-run interdependence between the two markets, they find no cointegration between REITs and stocks before 1993. However, cointegration is found after this reform. The authors argue OBRA to have changed the character of REITs towards behaving more like stocks because of the increased institutional REIT investments. This implies diminished diversification benefits from including US REITs in a multi-asset portfolio of US assets. Furthermore, Fang *et al.* (2017) employ non-linear cointegration to examine the dynamics between REIT markets and their corresponding stock markets in the US and Australia. The sample consists of REIT and stock indices for the period of 1999 – 2011. Non-linear structural break cointegration is found between REIT and stock markets in the US and Australia respectively. Hence, private investors with long investment horizons must consider that within-county diversification between REIT and stock markets might be limited. However, there are contradicting findings of the long-run within-country diversification potential of REITs. Westerheide (2006) examines the relations between REITs, stocks and bonds respectively for the period 1990 – 2004 in the US, Canada, Australia, Japan, the Netherlands, Belgium, France and Germany. Applying both Johansen's and Engle and Granger's tests for cointegration the author finds that REITs do not cointegrate with general stock markets nor with bonds in most cases examined. Supporting Westerheide's (2006) findings, Oikarinen *et al*. (2011) find that REITs and stock do not cointegrate within the US for the period of 1977 to 2008 using the Johansen's test for cointegration. This suggests within-country diversification might be possible in the long run.

Moreover, several studies targeting the Asian markets have been performed. Applying linear and non-linear cointegration tests, Wang *et al.* (2017) use a sample from 2006 to 2015 to explore the existence of a long-run equilibrium between the Taiwanese REIT and stock markets. Neither of the tests find cointegration between the variables. Hence, there is no long-run steady state and a combination of these assets offer diversification opportunities. Wang *et al.* (2017) argue that their findings might stem from the Taiwanese REIT market being less developed, and a stronger demand for direct real estate investments rather than for REITs from investors. The opposite finding is discovered through the ADL test made by Chang *et al.*, (2015). They investigate the existence of cointegration between the domestic REIT and stock markets in Japan and Singapore from 2003 to 2011. Their findings indicate cointegration between REITs and stocks in each country respectively, implying there are no long-run diversification benefits from mixing domestic asset classes within the countries. However, because of asymmetric adjustments towards the long-run equilibrium they stress the possibility for investors to gain arbitrage opportunities in the short run. The contradicting findings of Wang *et al.* (2017) and Chang *et al.*, (2015) might be explained by different maturity levels of the REIT markets. The Taiwanese REIT market is a nascent market, while Japan and Singapore have established REIT markets (EY, 2018), suggesting that the REIT regime maturity might influence the interdependence with the corresponding stock market and hence the long-run diversification potential in stock portfolios.

Considering the short-run dynamics of the diversification potential between REITs and stocks, Fei *et al*. (2010) use an AG-DCC-GARCH model to examine the conditional correlations between REITs, stock returns and direct real estate in the US for the period of 1987 – 2008. Conditional correlations are found to be both volatile and time dependent. Hence, the implications of these findings on diversification is that investors with short investment horizons continually must revise their portfolio compositions. Moreover, it is found that the macroeconomic factors being inflation, term and credit spreads and unemployment rate might explain these time-varying correlations. Niskanen and Falkenbach (2010) also conclude time-varying characteristics of the correlations between REITs and stocks. They investigate the diversification opportunities of combining European REITs with stock markets in Europe, the US and Asia Pacific for the period 2006 – 2009. Weak correlation is found between European REITs and the stock market of Asia Pacific, and a slightly stronger connection is found between European REITs and the US stock market. For private investors, this would imply that the short-term diversification potential is greater when European REITs are combined with stocks from Asia Pacific than stocks from the US. In line with this, other studies have concluded the US securitized real estate market to exhibit stronger connections with the European markets, than with the Asian Pacific markets (Liow and Ye, 2018*a*; Liow and Ye, 2018*b*). Moreover, as Niskanen and Falkenbach (2010) find higher correlation for European REITs in relation to the European stock market, the diversification potential from combining REITs and stocks within the European region is concluded to be smaller than the cross-regional combinations. Furthermore, Lee (2014) use DCC-GARCH modelling and find time-varying conditional correlations and volatility spillover between REIT and stock markets in Europe, the US and Asia Pacific from 2001 to 2011. Moreover, Liow *et al.* (2009) examine whether conditional correlations between securitized real estate markets and stock markets are synchronized using indices from the US, UK, Japan, Hong Kong and Singapore over the period 1984 – 2006. Investigating the securitized real estate markets and stock markets respectively, the results indicate low to moderate conditional correlations, with lower co-movements between securitized real estate markets than between stock markets. This suggests that international securitized real estate markets are less connected than international stock markets. Moreover, the conditional correlations are found to be synchronized, indicating that securitized real estate markets and stock markets co-move. Furthermore, the authors find the conditional volatility of the markets to also be synchronized, suggesting that the markets experience volatility shifts at the same time and in the same direction. Moreover, the authors find that the US volatilities tend to spill over to the other markets. This finding is supported by several studies analyzing international interdependence between securitized real estate market (Michayluk *et al*., 2006; Nikbakht *et al*., 2016; Liow and Ye, 2018*a*; Liow and Ye, 2018*b*). Furthermore, examining combinations of securitized real estate markets encompassing REITs in Australia, Japan, the US and UK with the global stock market Liow (2010) finds weak conditional correlations between securitized real estate markets and the global stock market. This implies short-run diversification potential between these assets. However, the author finds increasing average conditional correlations over time, suggesting increasing integration and decreasing diversification opportunities in the long run.

In sum, these studies highlight that there is no consensus of the long- and short-run diversification potential of REITs in stock portfolios. However, as most studies examine the within-country diversification potential more research is needed to determine whether international combinations of REITs and stocks behave differently and thereby would offer greater diversification potential than within-country combinations of REITs and stocks.

2.4. Market characteristics in times of crises

2.4.1. Characteristics of REIT markets in times of crises

Studies have investigated the behavior of REIT markets during events changing normal market conditions. Liow and Ye (2014) use indices of securitized real estate including REITs from the US, France, Germany, UK, Italy, Australia, Japan, Hong Kong and Singapore over the period of 1990 – 2012. The authors find that only a few of the examined securitized real estate markets responded with increased volatilities during the Asian financial crisis, Russian financial crisis and Brazil crisis. However, for the GFC all investigated securitized real estate markets exhibited greater volatilities than in normal market conditions. The stronger reaction to the GFC is argued to be a consequence of its origin from the subprime mortgage crisis. Moreover, Coën and Lecomte (2019) investigate whether securitized real estate markets, including REITs in some of the 14 countries studied, are driven by global or country specific factors and whether the conditions change during GFC. For the period of 2000 – 2015, Asia Pacific is found to provide the best diversification benefits for an international investor since most securitized real estate markets in this region are influenced by country-specific market risk rather than global market risk. However, for the aggregated sample there has been a general shift from a combination of global and local factors to a domination of global factors after the GFC. This agrees with studies finding that the Asian REIT markets have become increasingly connected to the US REIT market (Tsai and Lee, 2012; Chang and Chen, 2014). The increasing influence of global factors after the GFC imply that securitized real estate markets, encompassing REITs, are now more interdependent.

Moreover, Haran *et al*. (2016) suggest that emerging real estate markets have other characteristics than developed real estate markets. Examining European securitized real estate markets, the authors conclude there are diversification benefits from combining emerging and developed securitized real estate in a multi-asset portfolio. Furthermore, Pham (2012) investigates the interlinkages between emerging and developed REIT markets of seven Asian countries during the GFC. The author finds lower correlations among emerging REIT markets than among developed REIT markets. Moreover, in line with Liow and Ye (2014) and Coën and Lecomte (2019), Pham (2012) finds increased correlations during GFC. The author concludes the existence of spillover effects, with developed markets leading emerging markets. Effectively, emerging securitized real estate markets cannot be expected to provide a greater shelter against financial turbulence than their developed counterpart. However, their special characteristics might provide diversification benefits in normal market conditions. Emerging markets grow rapidly and their economic importance is increasing (Pham, 2012; Liow and Schindler, 2014) while investors lack knowledge and information of their characteristics. Hence, understanding linkages between emerging and developed markets is crucial to investors and requires more attention.

2.4.2. Characteristics of the REIT-stock relation in times of crises

Studies have focused on the relation between REIT and stock markets during financial crises. Yüksel *et al*. (2017) examine the impact of the GFC on the relation between REIT and stock markets within countries in Europe, North America and Asia Pacific from 2001 – 2014. The authors employ both a dynamic cointegration model and Johansen's cointegration. Through the Johansen approach no cointegration is found between the markets. However, through the dynamic cointegration approach the markets are found to cointegrate, implying no diversification from combining these markets. The authors argue the Johansen approach is unable to capture the structural break of the GFC and EDC which resulted in more interdependent markets. Moreover, the strong interdependence between REIT and stock markets is argued to result from investors fleeing both markets because of the specific characteristics of the GFC, where both the real estate market and the stock market were heavily affected. Hence, long-run diversification might still exist in normal market conditions not marked by financial crisis of this magnitude.

Hoesli and Kustrim (2013) study the relationship between Australian, UK and US stock markets and their corresponding securitized real estate markets. Additionally, the authors consider the Australian and UK securitized real estate markets respectively in relation to the US and the global securitized real estate market. With a sample period of 1989 – 2010, their t-BEKK covariance matrix and Joe-Clayton Copula formula indicate asymmetric volatility spillover from stock markets to their corresponding securitized real estate markets. The strongest spillover effect is found in the US while it is less pronounced within Australia and the UK. This implies better diversification opportunities from combining Australian or UK securitized real estate and stocks, than combining US securitized real estates and stocks. Moreover, Hoesli and Kustrim (2013) find that extreme negative shocks increase the level of volatility spillover between both domestic stock markets and securitized real estate markets, and between international securitized real estate markets. Furthermore, Tsai (2013) investigates Asian REIT markets from the listing day of each REIT index to July 2010 by employing GARCH and SWARCH models. Japan is found to be the most volatile REIT market among the countries studied, which is argued to emerge from Japan having the most developed financial markets in the sample with REIT and stock markets possibly being more integrated. Moreover, the conditional volatilities of the REIT and stock markets in Singapore, Japan, Taiwan and Hong Kong tend to increase during the GFC, possibly due to mature financial sectors being integrated with the US. Also examining the GFC, Chiang *et al*. (2013) study four

Asian markets from the listing day of each REIT to the end of April 2009 to examine the time-varying relationship among REIT and stock markets. Applying an MGARCH model and EVT, they find that both REIT and stock markets exhibit increased volatility after the GFC. The studies of Hoesli and Kustrim (2013), Tsai (2013) and Chiang *et al*. (2013) cover the GFC and find that the REIT and stock markets become increasingly correlated during and after the GFC. Furthermore, Milunovich and Trück (2013) investigate the relation between REITs and stock markets in eleven countries in Europe, North America and Asia Pacific. By using a multi-factor asset pricing framework and searching for excess co-movements between REIT markets and stock markets, they find increased interdependence between many of these markets for the period 2007 – 2009 which include the GFC. However, when studying the whole sample period of 2004 – 2011 no notable surplus co-movements is found between the markets. The authors conclude an increased possibility of excess co-movements between REIT and stock markets rather than between REITs and real estate markets during financial turmoil. This implies that including REITs in a stock portfolio does not provide the same diversification during a financial crisis and its aftermath, as during normal market conditions.

In sum, many studies point at increased interdependence between REIT and stock markets during the GFC which have important implications for investment decisions considering portfolio diversification. However, the GFC originated from a crisis in the real estate market, and it may be the case that REITs behave differently in terms of diversification possibilities during a financial crisis originating from the stock market. This is supported by Glascock *et al*. (2004), finding that the value of non-REIT stocks declined more than REIT stocks during the stock market decline of 1997.

2.5. Summarized empirical evidence of the REIT-stock relation

Table 2.1

Authors	Variables	Countries	Data	Method	Main Findings
Glascock *et al.* (2000)	REIT, stock and property indices, bond yields and CPI.	US	Jan 1971 – Apr 1997, (M), TS	Cointegration	REITs behave more like stocks after the structural break in 1993 on the US market, implying that diversification benefits from REITs might have decreased.
Westerheide (2006)	REIT, securitized real estate and stock indices, bonds, CPI	US, CA, AU, JP, NL, BE, FR, GE	1990 – 2014, (M), TS	EG- & Johansen's cointegration and ECM short-run dynamics model	No cointegration between REITs and stocks or bonds. REITs behave like their underlying asset and might contribute to diversification.
Oikarinen *et al.* (2011)	REIT, stock and property indices	US	1977 – 2008, (Q), TS	Johansen's cointegration	Direct and securitized real estate cointegrate. Moreover, REITs and stock do not cointegrate, implying REITs provide diversification potential in stock portfolios.
Fang *et al.* (2017)	REIT and stock indices	US, AU	Jan 1999 – Feb 2011 (US) Mar 2000 – Feb 2011 (AU) (D), TS	Non-linear cointegration	Non-linear structural break cointegration is found between REIT and stock markets in both the US and AU.
Wang *et al.* (2017)	REIT and stock indices	TW	Jan 2006 – Dec 2015 (D), TS	GH cointegration test and TV-VECM	Neither linear nor non-linear cointegration between the Taiwanese REIT and stock market is found.
Chang *et al.* (2015)	REIT and stock indices	JP, SG	2003 – May 2011, (D), TS	Threshold ADL test for cointegration and Granger causality	Cointegration between stock and REIT markets within each country. No cointegration between JP and SG REIT markets.

Fei *et al*. (2010)	REIT and stock indices, CPI, HPI, unemployment rate, term spread, credit spread, inflation rate and three-month T-bill rate	US	Jan 1987 – May 2008, (M), TS	AG-DCC-GARCH	Conditional correlations between REITs, stocks and direct real estate are time-varying and volatile and might be explained by macroeconomic factors such as inflation, unemployment rate and term- and credit spreads.
Niskanen and Falkenbach (2010)	REIT, stock, fixed income and commodity indices	EU, APAC, US	March 2006 – Dec 2009, (D), TS	Pearson correlation coefficient and OLS-regression	High correlation between European REIT and stock markets. Weaker correlation in relation to US stock market and even weaker in relation to Asia Pacific stock market.
Liow and Ye (2018*b*)	Securitized real estate and stock indices	US, UK, FR, GE, AU, JP, HK, SG	Jul 2007 – Jun 2014, (W), TS	Bivariate SWARCH model, MS-VAR model	Volatility spillover from the US to EU. More reduced benefits from diversification between EU-US than between Asia-US.
Lee (2014)	REIT and stock indices	AU, BL, GE, IT, JP, NL, SG, UK, US	Jan 2001 – Sep 2011, (D), TS	8 types of MGARCH and Portfolio Optimization	There is asymmetric volatility spillover between domestic REIT and stock markets.
Liow *et al*. (2009)	Securitized real estate and stock indices	HK, JP, SG, US, UK	Jan 1984 – March 2006, (M), TS	DCC-GJR-GARCH	Synchronization between pairwise correlations of securitized real estate markets and their corresponding stock markets indicate limited diversification opportunities.
Liow (2010)	Securitized real estate (including REITs) and stock indices	AU, JP, US, UK	Jan 1990 – Oct 2007, (W), TS	DCC-GJR-GARCH	Synchronization between pairwise correlations of securitized real estate and their corresponding pairwise stock market-correlations, but weak correlation between global stock market and securitized real estate markets. Different time- and market cycle-varying volatility linkages between securitized real estate markets.
Coën and Lecomte (2019)	Securitized real estate (including REITs) and stock indices	US, CA, JP, SP, HK, AU, UK, GE, FR, NL, SE, IT, SW, BE	Feb 2000 – Dec 2015, (M)	Asset pricing models	The GFC resulted in securitized real estate being more affected by global than local factors, and resulted in more homogenous markets. Hence, decreased possibilities of international diversification.
Yüksel *et al*. (2017)	REIT and stock indices	GE, FR, IT, NL, DE, UK, US, JP, AU, CA	Jan 2001 – Feb 2014, (D), TS	Johansen's cointegration, Dynamic cointegration analysis	Cointegration within the countries is identified through the dynamic approach, resulting from the impact of GFC and EDC. However, no cointegration identified with Johansen's approach.
Hoesli and Kustrim (2013)	Securitized real estate and stock indices	AU, UK, US, Global	Dec 1989 – May 2010, (W), TS	MGARCH model, t-BEKK covariance matrix and Joe-Clayton Copula	Increased volatility spillover in extreme negative shocks. Strongest spillover within the US markets and from the US to global markets.

Tsai (2013)	REIT and stock indices	SK, SP, JP, TW, HK, MA, TH	Listing day of REITs – July 2010, (D), TS	GARCH and SWARCH model	The level of integration and maturity of financial markets either within a country or between countries might lead to increased volatility.
Chiang *et al*. (2013)	REIT and stock indices	JP, HK, TW, SG	Listing day of REITs – April 2009, (D), TS	MGARCH-vech model and EVT	Time-varying correlations. Increased correlations during and in the aftermath of the GFC.
Milunovich and Trück (2013)	REIT and stock indices	UK, FR, BE, NL, GR, US, CA, JP, HK, SP, AU, NZ	Jan 2004 – Jun 2011, (W), TS	Multi-factor asset pricing model, EGARCH, excess correlation analysis	Increased interdependence between REIT and stock markets during the GFC.
Explanation of abbreviations					
(D) – Daily (W) – Weekly (M) – Monthly (Q) – Quarterly		TS – Time Series			

3. Methodological overview

In this thesis we examine the diversification potential between REITs and stocks through the level of co-movements in the long and short run as well as with constant and dynamic methods.

The long-run relation between REITs and stocks is studied applying Johansen's test for pairwise cointegration, which is a well-established method in this context (Glascock *et al.*, 2000; Westerheide, 2006; Oikarinen *et al.*, 2011; Yunus *et al.*, 2012) and argued to be well-developed regarding statistical properties (Sjö, 2015; Bilgili, 1998). Existence of pairwise cointegration implies that the long-run correlation goes towards one, hence there is no long-run diversification potential of combining the two assets. For private investors having long investment horizons, determining cointegration between assets is of utmost importance when evaluating the potential for diversification. Moreover, Granger non-causality (GNC) tests determine the directionality of the pairwise relations and provides information of which market that can be expected to forego the other in the short run. This provides the investor with a tool for predicting price changes between different markets.

The diversification potential can differ between long and short investment horizons. Therefore, we examine the short-run properties through an unconditional correlation analysis and a dynamic conditional correlation (DCC) GARCH framework. The DCC methodology is commonly used when examining similar economic issues (Liow *et al.*, 2009; Fei *et al.*, 2010; Liow, 2010) as it allows for time-varying characteristics of the co-movements. Hence, this methodology captures how changes in market conditions affect the diversification potential, which is of particular interest in times of crises. Moreover, as the DCC display how the co-movements fluctuate, it provides private investors with information on the stability of the short-run diversification potential and whether portfolios with short-term investment horizons need reallocation to remain diversified. Furthermore, the average level of conditional correlations over the period studied can be interpreted as the degree of long-run diversification potential, where a lower level of average conditional correlations is preferred.

The combination of the methodologies in this thesis is motivated by the lack of studies employing Johansen's cointegration, GNC and DCC-GARCH modelling together in this field of research. Thus, this study contributes with a comprehensive analysis of the long- and short-run dynamics of diversification from combining REITs and stocks.

3.1. Johansen's cointegration

Granger (2004) describes the prerequisite for cointegration as a pair of integrated variables that form a stationary linear combination. When two variables cointegrate, they create a long-run stationary relation together and follow a common stochastic trend in the long run. Consider two time series y_t and x_t being integrated of order $d(y_t, x_t) \sim I(d)$ where y_t denotes a REIT index and x_t denotes a stock index. Furthermore, consider the equation $x_t = \alpha + \beta y_t + \varepsilon_t$. If there exists a β for which the equation is integrated of order less than d $(d - z$ for example), then y_t and x_t are cointegrated of order $I(d - z)$, where $z > 0$. This can be summarized as $d - z, y_t, x_t \sim CI(d, z)$. The integrated variables do not follow the standard distribution. Thus, when deciding the order of integration, classic inference tests are inadequate. Instead unit root tests following the Dickey-Fuller distribution are proposed (Dickey *et al.* 1986). The Augmented Dickey-Fuller (ADF) test of Dickey and Fuller (1979) is applied in this study.

As cointegration demand integrated variables, the method is commonly applied to financial and macroeconomic time series since they often are non-stationary in level (Granger, 2004). The non-stationarity implies that means and variances are time-varying and the series is driven by a stochastic trend. Non-stationary variables can be transformed to show weak stationarity by differentiating d times. Thus, the time series then becomes integrated of order d (Engle and Granger, 1987). Near integration means that a series is so close to being integrated that its distribution is better described by that of an integrated series (Sjö, 2019). Moreover, autocorrelation in the residuals of $x_t = \alpha + \beta y_t + \varepsilon_t$ can indicate no cointegration, hence spurious regression results (Sjö, 2019). A spurious regression implies non-valid inference tests and unreliable results and can be expected when including integrated variables in a regression equation (Granger and Newbold, 1974). Cointegration is a method to circumvent the emerge of spurious regression (Sjö, 2019).

Johansen's methodology takes its starting point in a Vector Autoregressive (VAR) model that represents the variables under investigation. For the cointegration test, all variables in the VAR-model are integrated of order I(d). The test postulate asymptotic properties, and the VAR model is sensitive to misspecification when working with smaller samples (Sjö, 2015). It is critical that the VAR is correctly specified since determination of the critical values rely conditionally on normal distribution of residuals. Firstly, the optimal lag length is determined with the lag order selection criteria, so that the number of lags results in White Noise residuals which matters for inference. The test for lag order selection criteria propose the lag-length that minimizes the information criterion. When the variables included in the VAR-model are characterized by AR-processes the Akaike's Information Criteria (AIC) is the preferable information criterion (Sjö, 2019), which is employed in this study. However, choosing model according to the minimized AIC only holds in absence of autocorrelation. The appropriate lag-length should eliminate any existing autocorrelation and result in a parsimonious model. Thus, before deciding the final specification of the VAR-model, different versions are tested for autocorrelation with Lagrange Multiplier (LM) test, Portmanteau test and by studying the Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF). Moreover, the error terms should preferably be normally distributed which is examined through the Jarque-Bera (JB) test. However, this is a rare characteristic of financial data.

This testing procedure result in the final representation of the VAR-model, shown in Equation 1.

$$\mathbf{x}_t = \sum_{i=1}^{k} \mathbf{\Pi}_i \mathbf{x}_{t-1} + \mathbf{\Psi} \boldsymbol{D}_t + \boldsymbol{\varepsilon}_t \qquad (1)$$

In Equation 1, $\mathbf{x}_t$ is a vector of stochastic variables representing REIT and stock indices, $\mathbf{\Pi}_t$ is a coefficient matrix, $\boldsymbol{D}_t$ is a vector of deterministic variables including constants, trends and dummies and $\boldsymbol{\varepsilon}_t$ denotes a vector of error terms.

When the final specification of the VAR-model is determined, it can be rewritten in error correction form (VECM) by using the difference operator, as shown in the Equation 2.

$$\Delta\mathbf{x}_t = \mathbf{\Pi}\mathbf{x}_{t-1} + \sum_{i=1}^{k-1}\mathbf{\Gamma}_i\Delta\mathbf{x}_{t-1} + \mathbf{\Psi}\boldsymbol{D}_t + \boldsymbol{\varepsilon}_t \tag{2}$$

The number of cointegrating vectors is determined through the trace test. In the trace test, the rank of $\mathbf{\Pi}$ is determined, which represents the number of significant eigenvalues of the $\mathbf{\Pi}$-matrix. The number of stationary relations in the $\mathbf{\Pi}$-matrix is equal to the number of cointegrating vectors. For cointegration to exist, $\mathbf{\Pi}$ must be of reduced rank. When the rank is identified, the $\mathbf{\Pi}$-matrix can be written as $\mathbf{\Pi} = \boldsymbol{\alpha\beta}'$, where $\boldsymbol{\alpha}$ represent the vectors of adjustment to the long-run steady state, and $\boldsymbol{\beta}$ represent the vectors of cointegrating parameters. LM test for autocorrelation and JB test for normality are then performed to determine the stability of the VECM over time. Generally, five different models with different restriction levels are available for the trace test (Sjö, 2015). However, only three of those models are used in empirical tests. "Model 3" represented in Equation 3 include a deterministic trend in the $\mathbf{x}$-variables as well as constants in the cointegrating vectors.

$$\Delta\mathbf{x}_t = \sum_{i=1}^{k}\mathbf{\Gamma}_i\Delta\mathbf{x}_{t-1} + \boldsymbol{\alpha\beta}\mathbf{x}_{t-1} + \boldsymbol{\mu}_0 + \mathbf{\Psi}\boldsymbol{D}_t + \boldsymbol{\varepsilon}_t \tag{3}$$

"Model 2" represented in Equation 4 only allows for constant in the cointegrating vectors.

$$\Delta\mathbf{x}_t = \sum_{i=1}^{k}\mathbf{\Gamma}_i\Delta\mathbf{x}_{t-1} + \boldsymbol{\alpha}[\boldsymbol{\beta}', \boldsymbol{\beta}_0][\mathbf{x}_{t-1}, 1] + \mathbf{\Psi}\boldsymbol{D}_t + \boldsymbol{\varepsilon}_t \tag{4}$$

Lastly, "model 4" represented in Equation 5 allow for both constants and deterministic trends in the cointegrating vectors as well as deterministic trends in the variables.

$$\Delta\mathbf{x}_t = \sum_{i=1}^{k}\mathbf{\Gamma}_i\Delta\mathbf{x}_{t-1} + \boldsymbol{\alpha}[\boldsymbol{\beta}', \beta_1, \beta_0]'[\mathbf{x}_{t-1}, t, 1] + \boldsymbol{\mu}_0 + \mathbf{\Psi}\boldsymbol{D}_t + \boldsymbol{\varepsilon}_t \tag{5}$$

This study follows standard procedure when choosing model for the trace test, starting with model 3. If no meaningful cointegrating vectors are identified, model 2 and lastly model 4 is employed (Sjö, 2015). Finding a cointegrating vector imply the existence of an error correction mechanism (Engle and Granger, 1987), which separates long- and short-run effects. This implies Granger Causality in at least one direction (Sjö, 2019).

3.2. Granger non-causality

Causality was first proposed by Granger (1969). From Engle and Granger (1987) it follows that if a bivariate long-run stationary relation is identified in the cointegration analysis, causality in at least one direction must exist. The Granger non-causality (GNC) test is interesting when examining the relation between REIT and stock markets since Granger causality (GC) indicates the direction of the potential relation. Consider the time series y_t and z_t representing a REIT and a stock index. When testing for GNC, the null hypothesis is that y_t does not Granger cause z_t, and vice versa. If the null hypothesis is rejected, it indicates that y_t do Granger cause z_t. However, it is important to note that GC do not imply causality in the statistical cause and effect sense. Rather, GC from y_t to z_t implies that a change in y_t leads a change in z_t.

The bivariate GNC-test represented in Equation 6 to Equation 8 exercise the F-test to measure the significance of the parameter for lagged values of the independent variable in each equation of the VAR-model. Rejection of the null hypothesis in one direction imply GC (Sjö, 2019).

$$\mathbf{x}_t = \begin{bmatrix} y_t \\ z_t \end{bmatrix} \tag{6}$$

$$y_t = \sum_{i=1}^{k} \alpha_i y_{t-i} + \sum_{i=1}^{k} \beta_i z_{t-i} + e_t \tag{7}$$

$$z_t = \sum_{i=1}^{k} \gamma_i z_{t-i} + \sum_{i=1}^{k} \delta_i y_{t-i} + \eta_t \tag{8}$$

Equation 7 is the first part of the of the bivariate VAR-model, where y_t represents a REIT index and z_t represents a stock index. The lag-length, k, is determined to create a White Noise process of e_t. If the test coefficient β_i is significant at the chosen confidence level, the null hypothesis of no GC from z_t to y_t is rejected.

Equation 8 represents the second part of the bivariate VAR-model. The lag-length, k, is determined to create a White Noise process of η_t. If the test coefficient δ_i is significant at the chosen confidence level, the null hypothesis of no GC from y_t to z_t is rejected.

In the absence of cointegration, the GNC-test can still be performed to examine whether one variable leads the other. However, interpretation of the results must be made carefully as spurious GCs might arise when working with non-cointegrated variables (Sjö, 2019), or non-stationary variables (He and Maekawa, 2001).

3.3. DCC-GARCH

Autoregressive conditional heteroskedasticity (ARCH) models were introduced by Engle (1982) to deal with the differences between the unconditional and conditional variances in time series modelling. This kind of process is rarely observed in low frequency data but often observed in high frequency data; daily or weekly observations (Sjö, 2019). The returns of economic and financial time series tend to have time-varying and clustering errors, implying presence of heteroscedasticity. The ARCH model provides a solution to this as it allows for non-constant and time-varying conditional variances as a function of past residuals (Engle, 1982). However, as the ARCH process requires a quite long lag-length the generalized ARCH (GARCH) model was developed by Bollerslev (1986). The GARCH model provides a longer memory and a more flexible lag structure than the ARCH process, resulting in a more parsimonious model (Bollerslev, 1986). The univariate GARCH is represented by the mean Equation 9 and the variance Equation 10.

$$y_t = \beta x_t + \varepsilon_t, \varepsilon_t \sim D(0, h_t) \tag{9}$$

$$h_t = \omega + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{p} \beta_j h_{t-j} \tag{10}$$

The presence of GARCH processes in the REIT and stock time series is examined by analyzing plots of returns and squared returns of each individual series. If a plot indicates volatility clustering, the series contains a GARCH process. Additionally, univariate GARCH estimates for each individual time series confirm whether it is explained by GARCH processes. Working with financial returns, the most common GARCH specification is the GARCH (1, 1) (Nikbakht *et al*., 2016; Sjö, 2019). However, the lag-length of the AR process can differ. To obtain reliable estimates, the proper lag-length for the AR process in each univariate GARCH model can be determined looking at ACF and PACF in combination with the Portmanteau test. Including the number of lags that eliminate autocorrelation from the residuals generate consistent results. Furthermore, JB test for normality indicates the distribution of the series and whether GAUSS or Student's t-distribution should be applied in the multivariate GARCH models.

In a portfolio, it is important to examine how the included assets perform together. This can be done by employing a multivariate GARCH model, enabling examination of several assets' co-movements at a time. The constant conditional covariance (CCC) model, introduced by Bollerslev (1990) allows for time-varying conditional variances and covariances, while the conditional correlations are constant. However, the conditional correlations might not always be assumed constant for financial assets. Thus, the dynamic conditional correlation (DCC) version of the GARCH model introduced by Engle (2002) allows for time-varying conditional correlations and volatilities. Lee (2014) evaluates eight different specifications of multivariate GARCH models and find the DCC-GARCH to provide the best measure for conditional correlations between REIT and stock markets. Furthermore, Peng and Schulz (2013) argue for the need of studies employing DCC modelling when investigating the diversification from combining real estate and stocks, since DCC models are flexible and capture the time-varying characteristics of the co-movements between these assets. Therefore, to examine the dynamic short-run diversification potential between the markets in our study, we employ pairwise DCC-GARCH modelling.

The DCC model is specified in Equation 11 to Equation 15.

$$\boldsymbol{r}_t = \boldsymbol{\mu}_t + \boldsymbol{a}_t = \boldsymbol{\mu}_t + \boldsymbol{H}_t^{1/2}\boldsymbol{z}_t \tag{11}$$

Where $\boldsymbol{r}_t$ is the vector of log returns of REIT and stock indices at time *t*, $\boldsymbol{\mu}_t$ is the vector of the expected value of the conditional $\boldsymbol{r}_t$ and $\boldsymbol{a}_t$is the vector of mean-corrected returns of the two assets consisting of a Cholesky factorization of $\boldsymbol{H}_t$.

$$\boldsymbol{H}_t = \boldsymbol{D}_t\boldsymbol{R}_t\boldsymbol{D}_t \tag{12}$$

$\boldsymbol{H}_t$ in Equation 12 represent the conditional variance matrix which has to be positive definite, $\boldsymbol{D}_t$ is the diagonal matrix of conditional standard deviations at time *t* and $\boldsymbol{R}_t$ is the conditional correlation matrix of the standardized disturbances from $\boldsymbol{a}_t$ at time *t*, where $\boldsymbol{\epsilon}_t = \boldsymbol{D}_t^{-1}\boldsymbol{a}_t \sim N(\boldsymbol{0}, \boldsymbol{R}_t)$. From the $\boldsymbol{H}_t$ the conditional correlations are found using:

$$[\boldsymbol{H}_t]_{ij} = \sqrt{h_{it}h_{jt}\rho_{ij}} \tag{13}$$

Where,

$$\rho_{i,j,t} = \frac{q_{i,j,t}}{\sqrt{q_{i,i,t}}\sqrt{q_{j,j,t}}} \tag{14}$$

and,

$$q_{i,j,t} = \bar{\rho}_{i,j}(1 - \alpha - \beta) + \alpha(\epsilon_{i,t-1}\epsilon_{j,t-1}) + \beta(q_{i,j,t-1}) \tag{15}$$

The dynamic conditional correlation coefficient, rho is explained by Equation 14. Working with stationary time series one can expect mean reverting behavior. Thus, the mean reverting rho, $\bar{\rho}_{i,j}$ coefficient in Equation 15 is required to be significant and positive. Furthermore, for $\boldsymbol{H}_t$ to be positive it follows by the definition of $q_{i,j,t}$ in Equation 15 that $\alpha \geq 0$, $\beta \geq 0$ and $\alpha + \beta < 1$. These are restrictions put on each GARCH variance equation. The implication if these restrictions do not hold is that shocks in the variances of the variables included has permanent effects. When the sum of α and β is between 0 and 1, the volatility pattern is mean reverting. A sum close to unity means there is a long memory and effects from shocks dies out slowly while the reverse indicates short memory and quick reversion to normal conditions (Sjö, 2019). The α and β are estimated through the two-step procedure of quasi maximum likelihood estimation. The significance of these parameters indicates existence of heteroscedasticity which motivates the use of a GARCH model. If the α and β coefficients are insignificant, the GARCH approach is not suitable. Furthermore, it is necessary to control for autocorrelation in the bivariate models to make sure the estimates are consistent and reliable for inference.

4. Data and descriptive statistics

4.1. Data

To examine how REITs can contribute to diversification when added in European stock portfolios we use stock indices from seven European countries, and REIT indices from three regions.

There is a lack of studies examining international diversification of REITs, and in particular a lack of studies considering the European stock markets in relation to international REIT markets. Hence, we fill this research gap by examining the European stock markets of UK, Germany, France, Spain, Finland, Sweden and Denmark. The chosen indices represented in Table 4.1 are good proxies for the whole market in each country since they represent the most traded stocks. The stock markets in this study are chosen based on their high level of development (FTSE Russell, 2019) and they are therefore easily accessed by investors. Moreover, developed and transparent stock markets encourage investments since they are often characterized by information transparency and well-defined property rights increasing the confidence of investors (El-Wassal, 2013). The European countries in this study also exhibit high levels of GDP per capita (World Bank, 2019*b*). This indicates developed economies where individuals are likely to seek returns in the stock market for their savings (El-Wassal, 2013). Hence, it is likely to expect private investors to hold shares in stock portfolios of the developed country. Furthermore, developed markets are suggested to be affected by financial integration to a greater extent than emerging markets (Donadelli and Paradiso, 2014). Thus, as stocks from developed European countries can be expected to strongly correlate with each other (Meric *et al*., 2015) it is likely that investors turn to other asset classes when diversifying their portfolios.

Table 4.1 Stocks

Stock Market	Index (RIC[a])	Sample
Sweden	OMXS30 (.OMXS30)	2007-07-06 – 2019-03-08
Finland	OMXH25 (.OMXH25)	2007-07-06 – 2019-03-08
France	CAC40 (.FCHI)	2007-07-06 – 2019-03-08
Germany	DAX30 (.GDAX)	2007-07-06 – 2019-03-08
UK	FTSE100 (.FTSE)	2007-07-06 – 2019-03-08
Spain	IBEX35 (.IBEX)	2007-07-06 – 2019-03-08
Denmark	OMXC20 (.OMXC20)	2007-07-06 – 2019-03-08

[a] Thomson Reuters Instrument codes (RIC) are presented to facilitate replication of the study.

The REIT markets selected for this study are the US, Europe and Asia Pacific. The indices representing each market are displayed in Table 4.2. The purpose of including REIT markets originating from these regions is to analyze whether the diversification opportunities from combining European stocks and REITs changes with respect to regional market specific characteristics. REITs were first introduced in the US, which is the most mature REIT market in the world (EY, 2018). As shown in Graph 2.1, the US REIT market outperforms global REIT indices, and sometimes also the global stock market which makes it an attractive REIT market for investors. Moreover, Asia Pacific and Europe have different development levels of their REIT markets with a mix of established, emerging and nascent REIT markets in different countries (EY, 2018). As there are different characteristics of emerging and developed securitized real estate market cycles (Haran *et al*., 2016), the European and Asia Pacific regions are divided in emerging and developed REIT markets. This enables us to study differences in diversification between developed and emerging REIT markets for investors holding European stocks. As displayed in Table 4.2, the index for emerging Asia Pacific was launched after the other indices, hence a limitation of our study is that data is not available for the whole sample period for this region.

Table 4.2 REITs

REIT Market	Index (Datastream Code[a])	Sample
US	FTSE Nareit All Equity REITs (NAREQU$)	2007-07-06 – 2019-03-08
Developed Asia Pacific	FTSE EPRA Nareit Dev Asia (FEASIA$)	2007-07-06 – 2019-03-08
Emerging Asia Pacific	FTSE EPRA Nareit EM A-Pac (FEEAPC$)	2008-10-31 – 2019-03-08
Developed Europe	FTSE EPRA Nareit Dev Europe REITs (FEEURT$)	2007-07-13 – 2019-03-08
Emerging Europe	S&P European EM REIT (SBBREE$)	2007-07-06 – 2019-03-08

[a] Thomson Reuters Datastream codes are presented to facilitate replication of the study.

Another limitation of our study is the lack of REIT indices being constructed with the same components which would improve reliability of the results and facilitate comparison. As shown in Table 4.3 the US REIT index consists of equity REITs. For the European REIT indices, no information on what types of REITs that are included is available, hence there might be a mix of mortgage and equity REITs. The Asia Pacific REIT indices consist of both REITs and real estate holding and development companies. This is not optimal since we cannot examine the REIT-stock relation exclusively. However, the growing economic importance of the Asia Pacific region (Liow and Schindler, 2014) makes it attractive to investors, hence the market characteristics of Asia Pacific are important to examine despite the lack of all-REIT indices. Moreover, the FTSE EPRA Nareit indices are constructed as investable, making them available for private investors. Furthermore, the index for emerging Europe only contains three constituents which might appear as few. However, given our database, the chosen indices were the best options for the purpose of our study, allowing us to examine different REIT regions as well as developed and emerging markets within these regions. Despite the shortcomings we argue these indices to be useful proxies for the selected REIT markets and highlight the need for improved indices to examine the performance and characteristics of these REIT markets.

All indices are converted to US dollars to facilitate comparison of the results. The stock indices are collected in their local currency and transformed to US dollars using the exchange rate conversion function in Thomson Reuters Datastream. All REIT indices are collected in US dollars directly from Thomson Reuters Datastream. The indices are collected as price indices in weekly frequency for the period of 2007-07-06 to 2019-03-08. Weekly frequency is chosen since high frequency data, preferably daily or weekly, is required when modelling GARCH (Sjö, 2019). Moreover, weekly data smooth out noise from differences in stock market closures that is present in daily data.

Table 4.3 REIT characteristics

REIT Market	Coverage	Countries	Largest weight in:	No. of constituents	Average net market cap of constituents	Median net market cap
US	Equity REITs	US	Infrastructure REITs (14.24%), Apartments (11.39%), Health Care (10.53%)	169	6,198 USDm	2,710 USDm
Developed Asia Pacific	REITs and Real Estate Holding & Development companies	Australia, Hong Kong, Japan, New Zealand, Singapore	Japan (42.01%), Hong Kong (31.06%), Australia (17.44%)	81	4,996 USDm	2,796 USDm
Emerging Asia Pacific	REITs and Real Estate Holding & Development companies	China, India, Indonesia, Malaysia, Philippines, Thailand	China (73.23%), Philippines (10.42%), Thailand (7.20%)	94	1,508 USDm	661 USDm
Developed Europe	REITs	Belgium, Ireland, Italy, Netherlands, France**, Germany**, Spain**, UK**	UK (45.09%), Netherlands (19.60%), France (16.53%)	64	1,957 USDm* (1,735 EURm)	906 USDm* (803 EURm)
Emerging Europe	REITs	Turkey, Greece	-	3	-	-

* Converted from EUR to USD to the rate 0,886879 EUR/USD 2019-04-11 at https://www.xe.com/sv/currencyconverter/convert/?Amount=1&From=EUR&To=USD.
** These countries also appear as stock indices in our study.

4.1.1. Defining the sub-samples

During the sample period of 2007 – 2019, some events have occurred in the financial markets with different levels of world-wide impact. When analyzing the graphics of our series in level presented in Graph A.1 and Graph A.2 in the Appendix, some of these events have had remarkable influence on our data.

Starting in the US housing market, the securitization of mortgages led to the GFC, which linked the stock and real estate markets together in a recession of great magnitude (Levin and Coburn, 2011). The aftermath of the GFC, brought forth a new crisis in the Eurozone, the EDC, where high debt and downturns in economics in sovereign countries from the monetary union lead to default of governments. Greece was one of the countries suffering the most from the EDC (Gourinchas *et al*., 2017), and in 2010 the bailout plan for Greece was initiated (Yüksel *et al*., 2017). During this period, emerging Asia Pacific was the only index not experiencing a downturn as displayed in the graphics in Graph A.1 and Graph A.2 in the Appendix. As for the stock indices, Spain and France exhibit the heaviest reaction to this crisis. In the following years, the European stock indices have experienced two peaks in 2014 and 2018 with a lighter downturn in the middle. The developed Europe REIT index follow a similar pattern, while the other REIT markets exhibit patterns different from that of the stock markets.

The graphic analysis suggests that the period with the most recurrent pattern for both REIT and stock indices is that covering the GFC. Combined with evidence from studies that have found increased correlations during the GFC (Hoesli and Kustrim, 2013; Tsai, 2013; Chiang *et al*., 2013; Milunovich and Trück, 2013), effectively the sample must be divided in two sub-samples representing the periods during and post the GFC for the cointegration analysis. The disparities in results between studies using a smaller sample just covering the GFC (Tsai and Lee, 2012; Chang and Chen, 2014) and studies using an extended sample (Gu *et al*., 2017) further motivates the need for a divided sample to capture the specific characteristics of the crises-period. Because we have European stock indices, and two European REIT indices in our sample, we argue for including the EDC in the during crises-period too, since it is likely that this economic event influenced stock market movements during this time. This will result in more reliable results since we aim to isolate effects resulting from the extreme economic turmoil of the GFC and EDC and the market specific characteristics for this period. These results can then be compared with the post-crises period. Two sub-samples are chosen following the volatility regimes identified for the GFC and EDC by Liow and Ye (2014) when examining securitized real estate markets in the US, Europe and Asia Pacific. Although the starting date of the GFC is still under debate, we have chosen a date close to that employed by several previous studies (Yüksel *et al*., 2017; Yang *et al*., 2012). The starting date of the first sub-sample is also determined by data availability of the REIT indices.

- During-crises: 2007-07-06 to 2011-12-30, covering a period of crises with increased volatility and abnormal market conditions resulting from GFC and EDC.

- Post-crises: 2012-01-06 to 2019-03-08, representing the aftermath of the crises and a period of financial recovery.

4.2. Descriptive statistics

As displayed in Table 4.4 and Table 4.5 the mean values increase over time for all series except for France and the emerging Europe REIT index. The series are generally not normally distributed as indicated by JB, kurtosis and skewness except for Germany in the post-crises period, displaying an insignificant JB-statistic. Normal distributions are preferred as they generate efficient estimates. Absence of normality causes inefficient estimates; however, normality is an asymptotic characteristic that is assumed to be exhibited when the number of observations in a sample goes towards infinity. We consider no autocorrelation to be the main priority for our sample, since absence of White Noise residuals causes inconsistent estimates which has serious consequences for estimations and inference.

Table 4.4 REITs

	US		Developed Asia Pacific		Emerging Asia Pacific		Developed Europe		Emerging Europe	
	during	*post*	*during*	*post*	*during*	*post*	*during*	*post*	*during*	*post*
Mean	398,57	603,51	1550,62	1717,28	1817,66	2643,38	731,20	770,67	50,44	32,41
Median	416,34	617,25	1468,62	1742,74	1915,58	2458,31	675,52	782,05	51,34	30,49
Maximum	596,88	722,86	2561,25	2062,60	2369,04	4255,77	1232,58	930,94	83,99	58,66
Minimum	163,57	443,99	747,02	1292,91	925,96	1652,17	347,15	537,32	15,89	11,89
Std. Dev.	96,44	68,59	398,90	126,78	339,69	533,54	209,54	85,39	16,17	10,88
Skewness	-0,40	-0,38	0,63	-0,66	-1,08	0,94	0,66	-0,35	-0,08	0,16
Kurtosis	2,36	1,95	3,05	3,80	3,31	2,98	2,44	2,39	2,32	2,45
Jarque-Bera Probability	10,36 ***	26,23 ***	15,76 ***	37,56 ***	32,83 ***	55,06 ***	19,79 ***	13,42 ***	4,71 *	6,22 **
Observations	235	375	235	375	166	375	234	375	235	375

*, **, *** Indicate rejection of the null hypothesis that the series is normally distributed at the 10%, 5% and 1% significance level respectively.

Table 4.5 Stocks

	Sweden		Finland		France		Germany		UK		Spain		Denmark	
	during	*post*	*during*	*post*	*during*	*post*	*during*	*post*	*during*	*post*	*during*	*post*	*during*	post
Mean	141,58	179,62	3165,44	3787,79	5574,51	5393,01	8688,80	12093,98	9179,49	9753,81	15427,36	11353,59	72,69	127,25
Median	144,10	180,72	3019,96	3776,67	5344,53	5396,24	8526,51	12149,66	8833,47	9723,23	14711,92	11271,51	71,38	133,17
Maximum	196,93	213,74	4833,63	5145,52	8427,03	6874,68	11862,67	16586,53	13695,64	11773,55	23180,90	15143,33	97,48	173,48
Minimum	65,90	131,54	1509,07	2207,94	3208,66	3647,58	4641,74	7479,80	4996,33	8066,76	8782,24	7497,98	36,21	68,13
Std. Dev.	31,63	16,81	806,99	704,28	1352,14	674,94	1696,19	1943,66	2074,81	816,16	3553,90	1541,65	15,39	26,62
Skewness	-0,58	-0,20	0,17	-0,02	0,63	-0,14	-0,19	-0,13	0,41	0,32	0,49	0,23	-0,39	-0,57
Kurtosis	2,62	2,36	2,15	2,42	2,31	2,43	2,20	2,60	2,54	2,35	2,24	2,60	2,26	2,20
Jarque-Bera Probability	14,66 ***	8,93 **	8,13 **	5,27 *	20,21 ***	6,31 **	7,76 **	3,46 -	8,68 **	13,06 ***	15,08 ***	5,88 *	11,31 ***	30,52 ***
Observations	235	375	235	375	235	375	235	375	235	375	235	375	235	375

*, **, *** Indicate rejection of the null hypothesis that the series is normally distributed at the 10%, 5% and 1% significance level respectively.

4.3. Unconditional correlation analysis

A first attempt of examining the linkages between the stock and REIT markets is performed through an unconditional correlation analysis for each sub-period. Low correlations between the returns of real estate markets and other asset classes is often an argument for including real estate in stock portfolios (Nareit, 2018). As displayed in Table 4.6, all correlations are positive but less than unity. This implies there are diversification opportunities from combining REITs and stocks. However, the degree of the co-movements is crucial for the level of diversification potential. Generally, the correlations are stronger in the during-crises period than in the post-crises period. Thus, there is greater gains from diversification of combining these assets in the post-period than in the during-period. Analyzing the REIT-stock pairs, generally the combination of REITs and UK stocks exhibit the strongest unconditional correlations. Thus, for the investor combining UK stocks with different REIT markets the diversification opportunities are smaller than in the other REIT-stock combinations. The weakest unconditional correlations generally appear when the Spanish or Danish stock markets are included. For both European REIT markets, combinations with the Danish stock market provides the greatest diversification potential, while for the remaining REIT markets the combination with the Spanish stock market exhibit the lowest correlations.

From a REIT market perspective, the lowest unconditional correlations appear when emerging Europe is combined with the stock markets. The only exception is for the combination of emerging Europe and Spain in the post-crises period. The strongest unconditional correlations are exhibited by developed Europe for both sub-periods with no exceptions.

The changes in unconditional correlation between the sub-periods indicate time-varying correlations. This argues for the use of a dynamic model like the DCC-GARCH when examining the correlation structures.

Table 4.6 Unconditional correlation matrix on returns

	US		**Developed Asia Pacific**		**Emerging Asia Pacific**		**Developed Europe**		**Emerging Europe**	
	during	*post*	*during*	*post*	*during**	*post*	*during*	*post*	*during*	*post*
Sweden	0,6669	0,4297	0,7107	0,4474	0,6020	0,4542	0,8238	0,6087	0,5607	0,3597
Finland	0,6400	0,4280	0,7213	0,4690	0,6276	0,4124	0,8431	0,6696	0,5408	0,3656
France	0,6173	0,4321	0,7329	0,4955	0,6260	0,4539	0,8443	0,7258	0,5578	0,4053
Germany	0,6430	0,4367	0,7081	0,4496	0,6154	0,4190	0,8117	0,6999	0,5647	0,3742
UK	0,6394	0,5118	0,7491	0,5524	0,6150	0,4778	0,8562	0,7471	0,5648	0,3593
Spain	0,5642	0,3829	0,6518	0,4301	0,5498	0,3740	0,8114	0,6356	0,5314	0,3906
Denmark	0,5891	0,3899	0,6979	0,4304	0,6147	0,3744	0,8018	0,5645	0,5382	0,3235

* Indicate shorter sample from 2008-11-07, instead of the whole during-crises sample.

4.4. ADF-testing

To perform cointegration tests the variables must be integrated of the same order. This is examined through a combination of graphic analysis, Q-tests and ADF-tests. The graphs of the series in level and first logarithmic differences are provided in Graph A.1 and Graph A.2 in the Appendix. The graphs of the series in level indicate non-stationarity for all indices. However, they appear to become stationary in first logarithmic difference. When examining the second logarithmic differences in graphics, some series appear to have more distinct signs of stationarity.

In accordance with the graphic analysis, the Q-test of the indices in logarithmic level indicate that the residuals follow an AR process, and become White Noise when the series are differentiated once. However, taking the second difference generally generate an MA process, which indicate that the series has become over differentiated. The results of the ADF-test are displayed in Table A.1 and Table A.2 in the Appendix. These tests indicate that for both sub-samples, the series become stationary in first logarithmic difference. This agree with the notion that financial time series generally are integrated of order one (Sjö, 2019). Thus, all series are considered I(1) and can be used for the pairwise cointegration tests.

4.5. Univariate GARCH

From the ADF-test procedure, we are confident that we can use the first logarithmic differences as estimates for the returns of the series when applying the DCC-GARCH models. Graphic analysis of the return and squared return series confirms the assumption of stationarity for all series. Moreover, these plots indicate volatility clustering, suggesting the series preferably can be explained by GARCH processes arguing for the use of DCC-GARCH modelling when examining time-varying diversification potential. To further ensure that the series follow GARCH processes, univariate GARCH models are estimated. The results are displayed in Table 4.7. The GARCH (1, 1) is an empirically common process in financial return series (Sjö, 2019) and hence employed in this study. However, the correct mean equation typically differ between AR(0) and AR(1).

Table 4.7 establish that all series have significant ARCH and GARCH processes, except for emerging Asia Pacific and emerging Europe that lack an ARCH process. However, these two series are still considered qualified to be included in the DCC-GARCH modelling as they contain significant GARCH processes.

The values of the significant ARCH and GARCH coefficients indicate how the individual series respond to shocks and how they recover from shocks. In general, the GARCH coefficient, β, is high implying that current volatility widely depends on past values of volatility. For the ARCH coefficient, α, the US and emerging Europe distinguish in exhibiting remarkably high and low coefficients respectively. This suggests the US has the strongest response to an unexpected event while emerging Europe has the weakest. Furthermore, the mean-reverting requirement of $\alpha + \beta < 1$ is fulfilled for all series which strengthens the results from the unit root tests and provides further evidence of stationarity. The overall combination of α and β summing up close to unity in combination with high values of the β implies long memory in the series. Thus, consequences of shocks to the individual series are not persistent but long-lived.

Table 4.7

Univariate GARCH

	Volatility clustering	Kurtosis > 3	AR (m)		ARCH (α)		GARCH (β)		$\alpha + \beta$	Observations
Stock										
Sweden	Yes	Yes	1	***	0,0910	***	0,8928	***	0,9838	610
Finland	Yes	Yes	0	-	0,0958	***	0,8912	***	0,9869	610
France	Yes	Yes	0	-	0,1025	**	0,8809	***	0,9833	610
Germany	Yes	Yes	0	-	0,0977	***	0,8704	***	0,9681	610
UK	Yes	Yes	0	-	0,1078	***	0,8649	***	0,9727	610
Spain	Yes	Yes	0	-	0,0927	**	0,8857	***	0,9784	610
Denmark	Yes	Yes	0	-	0,1224	**	0,8333	***	0,9557	610
REIT										
US	Yes	Yes	0	-	0,1847	***	0,7984	***	0,9832	610
Dev. Asia Pacific	Yes	Yes	0	-	0,1224	**	0,8636	***	0,9860	610
Em. Asia Pacific	Yes	Yes	0	-	0,1164	-	0,7938	***	0,9102	540
Dev. Europe	Yes	Yes	0	-	0,0980	***	0,8804	***	0,9783	608
Em. Europe	Yes	Yes	0	-	0,0486	-	0,9215	***	0,9701	610

*, **, *** Indicate significance at 10%, 5% and 1% level respectively.

5. REIT diversification in the long and short run

5.1. Johansen's cointegration and Granger non-causality

To examine the long-run properties of the REIT-stock relations, Johansen's cointegration has been employed. The cointegration results are displayed in Table 5.1 and Table 5.2. Following standard procedure for choosing model when performing the trace test generally resulted in model 3, displayed in Equation 3. However, for some REIT-stock pairs model 3 proposed two or more cointegration vectors. As we examine bivariate cointegration, the combination of two series can at most result in one vector. When no meaningful cointegration vectors were identified, model 2 or model 4 represented in Equation 4 and Equation 5 respectively were better suited.

Moreover, GNC has been employed to examine which market is leading which. The GNC-results are found in Table A.3 and Table A.4 in the Appendix. Regarding the results for the GNC analysis, the presence of spurious GCs must be considered when interpreting these results (He and Maekawa, 2001). Although two variables do not cointegrate, short-run relations in terms of GC can still exist. However, GCs found in the absence of cointegration should be interpreted with some caution since they cannot be cross-checked against an existing cointegration relation. Hence, the validity for this type of GC is lower compared to causalities found in the presence of cointegration.

5.1.1. The diversification potential of REITs

The main result from Johansen's test for cointegration for all periods is that REIT and stock markets do not cointegrate, meaning that the long-run correlation between these assets is zero. This suggests diversification potential for investors with long investment horizons and passive investment strategies, in line with the findings of Westerheide (2006), Oikarinen *et al*. (2011) and Wang *et al*. (2017). One explanation to these results might be that that stocks and REITs have different underlying asset pricing structures, causing them to behave differently in the long run.

However, Glascock *et al*. (2000) suggest that US REITs started to act more like US stocks after the increased institutional trade of REITs following the implementation of OBRA in 1993, and that their diversification potential diminished in effect. Our findings for the combination of European stocks and different REITs suggest that this result possibly was limited to the period and the within-country perspective studied. Although REIT markets have expanded steadily over the past decades and the institutional interest for REITs have grown with it (Nareit, 2018), REITs still seem to conserve their asset-specific characteristics that separate them from regular stocks when considering the international long-run perspective. Not even within Europe, where the countries share many common market characteristics, cointegration is found. Hence, increased institutional trade might not be the only factor influencing the interdependence between REIT and stock markets. The US REIT market is the most mature in the world (EY, 2018), hence the maturity level of the REIT market might also be an important factor to consider for diversification, where more developed REIT markets tend to become more connected with the corresponding stock market within a country. This argument is supported by the findings of Fang *et al*. (2017) and Yüksel *et al.* (2017) finding cointegration between developed REIT markets and their corresponding stock markets. However, no difference in long-run diversification potential between emerging and developed REIT markets is exhibited in our cointegration results. Moreover, the studies of Chang *et al*. (2015) and Wang *et al*. (2017) examine developed and emerging markets in Asia and find that the REITs and stocks in developed markets cointegrate while they do not cointegrate in the emerging market. These results suggest that the REIT regime maturity might be a factor affecting the interdependence with stock markets within a region, where emerging markets tend to offer greater diversification potential than developed markets. Comparing these empirical findings with our results, this reasoning does not seem to hold for Asia Pacific and Europe since both the emerging and developed market within the regions offer long-run diversification.

Table 5.1

Johansen's Cointegration During-Crises

REIT	Stock	Lags (log-level)	Model	Nr. CIV[a]	P-value[b]	VEC Model	EC Coefficient	Obs.
		Trace-test				Cointegrating Relation		
US	Sweden	5	4	1	0,1397	US=1,500256+0,912525SWE-0,000339TREND	-0,14448***	230
	Finland	5	3	0	0,2213	-	-	230
	France	5	3	0	0,8419	-	-	230
	Germany	5	3	0	0,2750	-	-	230
	UK	5	3	0	0,2037	-	-	230
	Spain	2	3	0	0,5704	-	-	233
	Denmark	3	2	0	0,0548	-	-	232
Developed Asia Pacific	Sweden	4	3	0	0,6625	-	-	231
	Finland	3	3	0	0,0954	-	-	232
	France	4	3	0	0,4230	-	-	231
	Germany	3	3	0	0,0943	-	-	232
	UK	4	2	0	0,1472	-	-	231
	Spain	3	3	0	0,6333	-	-	232
	Denmark	3	3	0	0,3710	-	-	232
Emerging Asia Pacific	Sweden	2	3	0	0,1698	-	-	164
	Finland	2	2	0	0,0543	-	-	164
	France	2	2	0	0,0668	-	-	164
	Germany	2	2	0	0,1390	-	-	164
	UK	5	4	1	0,2048	EMAPAC=-3,538968+1,261611UK-0,002051TREND	-0,020284	161
	Spain	4	2	0	0,0507	-	-	162
	Denmark	2	2	0	0,1643	-	-	164
Developed Europe	Sweden	5	3	0	0,2413	-	-	229
	Finland	2	3	0	0,1265	-	-	232
	France	2	3	0	0,1950	-	-	232
	Germany	2	3	0	0,0751	-	-	232
	UK	3	3	0	0,1106	-	-	231
	Spain	3	3	0	0,3387	-	-	231
	Denmark	4	3	0	0,4138	-	-	230
Emerging Europe	Sweden	4	3	0	0,0812	-	-	231
	Finland	4	2	0	0,1580	-	-	231
	France	3	3	0	0,1937	-	-	232
	Germany	5	3	0	0,0782	-	-	230
	UK	5	3	0	0,0983	-	-	230
	Spain	4	3	0	0,3613	-	-	231
	Denmark	6	3	0	0,2213	-	-	229

*, **, *** Indicate significance at the 10%, 5% and 1% level respectively.

[a]CIV = Cointegrating Vectors

[b] P-values are presented for the final test resulting in the determined number of cointegrating vector(s).

Table 5.2

Johansen's Cointegration Post-Crises

REIT	Stock	Lags (log-level)	Trace-test Model	Nr. CIV[a]	P-value[b]	Cointegrating Relation VEC Model	EC Coefficient	Obs.
US	Sweden	2	3	0	0,1249	-	-	373
	Finland	4	3	0	0,3314	-	-	371
	France	2	3	0	0,2423	-	-	373
	Germany	3	3	0	0,2727	-	-	372
	UK	2	3	0	0,1176	-	-	373
	Spain	2	3	0	0,2891	-	-	373
	Denmark	3	3	0	0,0688	-	-	372
Developed Asia Pacific	Sweden	4	3	0	0,0612	-	-	371
	Finland	4	3	1	0,1500	DEVAPAC=6,627123+0.099746FIN	-0,038953***	371
	France	3	2	0	0,0575	-	-	372
	Germany	4	2	0	0,1352	-	-	371
	UK	3	2	0	0,0619	-	-	371
	Spain	4	2	1	0,3085	DEVAPAC=5,409719+0,219958SPA	-0,037039**	371
	Denmark	3	2	0	0,0661	-	-	372
Emerging Asia Pacific	Sweden	2	3	0	0,2641	-	-	373
	Finland	4	3	0	0,5870	-	-	371
	France	4	3	0	0,4494	-	-	371
	Germany	4	3	0	0,5111	-	-	371
	UK	3	3	0	0,3478	-	-	372
	Spain	4	3	0	0,6402	-	-	371
	Denmark	3	3	0	0,3933	-	-	372
Developed Europe	Sweden	3	2	0	0,1368	-	-	372
	Finland	5	3	0	0,7213	-	-	370
	France	4	3	0	0,5645	-	-	371
	Germany	4	3	0	0,1502	-	-	371
	UK	4	3	0	0,4969	-	-	371
	Spain	3	2	0	0,1603	-	-	372
	Denmark	3	3	0	0,2401	-	-	372
Emerging Europe	Sweden	3	3	0	0,4773	-	-	372
	Finland	4	3	0	0,2789	-	-	371
	France	3	3	0	0,2553	-	-	372
	Germany	4	3	0	0,2102	-	-	371
	UK	3	3	0	0,4775	-	-	372
	Spain	4	3	0	0,8764	-	-	371
	Denmark	4	3	0	0,3429	-	-	371

*, **, *** Indicate significance at the 10%, 5% and 1% level respectively.

[a]CIV = Cointegrating Vectors

[b] P-values are presented for the final test resulting in the determined number of cointegrating vector(s).

Interestingly, our findings from the cointegration analysis suggest REIT markets in Asia Pacific and the US offer the same diversification as European REITs in relation to the European stock indices. This might seem counterintuitive since it could be expected that increased financial integration between European markets (Bley, 2009; Büttner and Hayo, 2011; Virk and Javed, 2017) would imply a higher level of interdependence between the European stock and REIT markets. However, the absence of cointegration could imply that REITs represent an asset class separated from stocks, and that the real estate market cycle is different from the business cycle determining long-run stock market returns. This would then explain the absence of cointegration within Europe, since the European stock and REIT markets are different in terms of market cycles and asset pricing structures. However, a cointegration analysis only tells investors whether a passive, long-term investment strategy holds or not. Which REIT market that offer best diversification potential in terms of the lowest correlation level and volatility cannot be determined from these results and the DCC analysis in the next section provide this information as a complement.

To our knowledge, not many studies have considered the long-run diversification potential between stocks and international REITs. Hence, this study provides investors with important information on what REIT markets to turn to when holding a portfolio of European stocks. Empirical evidence from within-country studies finds limited diversification potential, hence in line with our findings we argue international REITs to offer better long-term diversification than within-country diversification of stock portfolios with REITs.

5.1.2. Analysis of cointegrating relations

Although the general results suggest no cointegration, a few cointegrating vectors are identified in both samples. During the crises, two cointegrating vectors are found as shown in Table 5.1. However, only one of them exhibit a significant EC coefficient. As for the insignificant cointegrating vector identified in this period, it is not stable in the long run and is therefore not interpreted in our analysis. The relation identified between the US REIT market and the Swedish stock market is accompanied by the GNC-analysis found in Table A.3 in the Appendix, where the US Granger cause Sweden. The direction of this relation is anticipated. Sweden is a small open economy likely to be influenced by price changes in the US REIT market through changes in the US stock market, especially during the abnormal market conditions that followed the GFC (Ahmad *et al*., 2015). The EC Coefficient is 14.4 percent and represents the speed of adjustment to the long-run equilibrium after a shock in the system, where the Swedish stock market adjust to changes in the US REIT market following the direction of the GC identified. However, the absence of cointegration for this pair in the post-crises period suggest that the results are influenced by the GFC, and that the markets went back to more normal conditions in the aftermath of the crisis.

For the post-crises period, two vectors are identified as shown in Table 5.2, and both concern the REIT market of developed Asia Pacific. Developed Asia Pacific cointegrate with the Finnish and Spanish stock markets, hence they should follow the same stochastic trend in the long run. For both cointegrating relations, Granger causality runs from the stock market to the REIT market, implying price movements in the Finnish and Spanish stock markets leads price changes in the REIT market of developed Asia Pacific. However, the economic interpretation of the cointegrating relations identified for developed Asia Pacific is limited. The link between the Finnish and Spanish stock markets and the REIT market in developed Asia Pacific respectively is not theoretically evident. However, the Asia Pacific indices include not only REITs but also listed real estate in the form of real estate holding and development companies. Hsieh (2014) argue that listed real estate act more like listed stocks than direct real estate, and Liow *et al*. (2009) find that stocks generally exhibit stronger correlations than real estate. Hence, the composition of the developed Asia Pacific REIT index might explain these results. Moreover, the largest constituents in the developed Asia Pacific REIT index is Japan, Hong Kong and Australia, as shown in Table 4.3. Hence, potential trade patterns between these large economies and Finland or Spain might also explain the interdependencies. However, our study is unable to distinguish such factors and these results should be interpreted with some caution.

The findings of cointegration in the cases discussed above imply that the given stock and REIT markets follow the same stochastic trend in the long run. Since the long-term correlation approaches one, diversification is limited between these markets. This further suggest there is a constant risk premium between the cointegrating markets.

5.1.3. Diversification potential of REITs in times of crises

Out of the 31 GCs identified, 18 of them are from the during-crises period while 13 of them occur in the post-crises period. The general result is that stock markets lead REIT markets. One possible explanation for this unidirectional causality is that stock markets pick up information more quickly than REIT markets, hence a shock is reflected in stock pricing before it is reflected in the pricing of REITs. For the during-crises period the most common relation is unidirectional GC where the stock markets lead REITs, followed by bidirectional GCs and unidirectional GCs where REITs lead stocks. Bidirectional GC implies strong interdependence between assets because changes in stock returns lead changes in REIT returns, and changes in REIT returns lead changes in stock returns. For the post-crises period, the most common relation is stocks leading REITs. When changes in stock returns lead changes in REIT returns, stock returns can be used as a mean of predicting (in a Granger sense) changes in REIT returns. This mechanism can be used by investors wanting to reallocate a short-term portfolio.

Moreover, the GC analysis suggests that REIT and stock markets are more interdependent during the crises, which is supported by the findings of Hoesli and Kustrim (2013) and Milunovich and Trück (2013). The directionalities of the GCs are mixed during the crises, with both bidirectional and unidirectional relations. This is different from the post-crises period where the dominant GC identified is unidirectional where stock markets lead REIT markets. The abnormal market conditions during the crises (Liow and Ye, 2014) and the increased interdependence between assets (Glascock *et al*., 2000; Hoesli and Kustrim, 2013; Tsai, 2013; Chiang *et al*., 2013) might explain these results. Moreover, for the post-crises period no GC is found for emerging Europe, while during the crises all pairs exhibited GC. This suggests that the emerging Europe REIT market was significantly more interdependent during the crises than afterwards. Greece is a main constituent of the emerging Europe index, and Greece was highly affected by the EDC (Gourinchas *et al*., 2017). Hence, this could explain the drastically changed behavior and increased interdependence during the crises. For developed Europe, generally no pairs exhibit GC over the whole sample. This suggest that interdependencies between emerging and developed markets within a region might differ, both in crises and in normal market conditions.

Moreover, only one cointegrating relation is identified during the crises which suggest that REIT and stock markets offer long-run diversification for investors even in the turmoil of the GFC and EDC. This was unanticipated, since we expected more markets to cointegrate due to the magnitude of GFC. Since the GFC originated from the real estate sector and then hit the financial markets, investors fled both the REIT and stock market (Yüksel *et al*., 2017), which would have resulted in increased interdependence due to negative trends in both markets. Moreover, most of the indices included in this study are European, hence we believed the EDC to have a strong impact on particularly those indices leading to increased interdependencies due to abnormal market conditions in times of crises. Rather, our findings indicate that combining European stock with US, European and Asia Pacific REITs generally have long-run diversification potential both during the crises as well as after. Yüksel *et al*. (2017) find strong cointegration between these markets due to the GFC and EDC through a dynamic cointegration approach and argues that the use of Johansen's cointegration do not account for structural breaks. Thus, the choice of methodology might explain our results. However, Johansen's cointegration is an established method to use in this context, and dividing the sample in during-crises and post-crises periods should correct the potential bias from not employing a method accounting for structural breaks. Moreover, Yüksel *et al*. (2017) argue they perform the first study employing this dynamic co-integration approach when examining the REIT-stock relation, and the study is performed on a within-country basis. Hence, we argue more studies are needed to confirm their arguments of dynamic cointegration methods being superior to Johansen's test for cointegration, especially in the context of international diversification between REITs and stocks.

5.2. DCC-GARCH

Generally, diversification benefits appear when correlations between assets are low. As our DCC-GARCH investigate the dynamic conditional correlations between pairs of REIT and stock indices, the time-varying short-run diversification opportunities from combining these assets can be determined. By identifying potential short-run deviations from the long-run cointegrating relations and providing information on the average level of conditional correlations, the DCC analysis is a good complement to the cointegration analysis. The DCC results consist of parameter estimates in Table 5.3 and outputs in Graph $5.1a - 5.1e$.

Table 5.3 illustrate the parameters of α, β and $\bar{\rho}_{ij}$ when fitted as the best specified and parsimonious model according to criteria for lag-length, significance and absence of autocorrelation. When testing for autocorrelation for developed Asia Pacific combined with Sweden, Finland, France, Germany and UK, autocorrelation is present up to five lags. This is true for the US-Denmark combination as well. However, white noise residuals are exhibited for ten or more lags. As tests for autocorrelation are more efficient with fewer lag-lengths, the DCC results for the mentioned combinations must be interpreted with some caution. As displayed in Table 5.3, the β conditions are fulfilled for all asset-pairs except for the combination of emerging Asia Pacific and Spain. Insignificance of the β coefficient implies there is no GARCH process. Thus, the modelling of this pair gives unreliable results and is therefore excluded from the analysis. There are some pairs containing insignificant α coefficients. This implies that shocks do not significantly affect the performance of these series and that the volatilities of the conditional correlations are relatively low over the period. However, these series still contain a GARCH process. Hence, the short-run diversification possibilities can still be examined from the level of co-movements. Notably, the combination of emerging Europe and Spain exhibit a remarkably low value of α. Hence, this result is not interpreted. In all pairs where the β coefficient is significant, the sum of α and β is less than unity and the condition for mean reversion is fulfilled. Additionally, the mean reverting conditional correlation coefficients, $\bar{\rho}_{ij}$, are positive and significantly separated from zero. Based on these results, we suggest that the proposed DCC analysis is suitable for investigating the time-varying diversification possibilities.

Table 5.3

DCC-GARCH

REIT	Stock	AR (m)	$\bar{\rho}_{ij}$	ARCH (α)	GARCH (β)	$\alpha + \beta$	Observations
	Sweden	0	0,4757 ***	0,0414 **	0,9433 ***	0,9846	610
	Finland	0	0,4702 ***	0,0443 **	0,9345 ***	0,9788	610
	France	0	0,4915 ***	0,0660	0,8689 ***	0,9349	610
US	Germany	1	0,4694 ***	0,0283	0,9534 ***	0,9817	610
	UK	1	0,5501 ***	0,0596 **	0,8932 ***	0,9527	610
	Spain	0	0,4397 ***	0,0411	0,8456 ***	0,8867	610
	Denmark[a]	0	0,4058 ***	0,0309	0,9110 ***	0,9419	610
	Sweden[a]	1	0,5025 ***	0,0300 **	0,9541 ***	0,9841	610
	Finland[a]	1	0,5618 ***	0,0353 **	0,9285 ***	0,9638	610
	France[a]	0	0,5506 ***	0,0483 ***	0,9068 ***	0,9551	610
Developed Asia Pacific	Germany[a]	0	0,5074 ***	0,0360 ***	0,9312 ***	0,9672	610
	UK[a]	0	0,6134 ***	0,0344 **	0,9256 ***	0,9600	610
	Spain	0	0,5060 ***	0,0395 ***	0,9244 ***	0,9639	610
	Denmark	0	0,4980 ***	0,0204	0,9479 ***	0,9683	610
	Sweden	1	0,4820 ***	0,0244 *	0,8985 ***	0,9229	540
	Finland	1	0,4805 ***	0,0406 ***	0,9175 ***	0,9581	540
	France	1	0,4939 ***	0,0436 **	0,9023 ***	0,9459	540
Emerging Asia Pacific	Germany	0	0,4377 ***	0,0382 ***	0,9228 ***	0,9610	540
	UK	0	0,4959 ***	0,0302 **	0,9366 ***	0,9668	540
	Spain	1	0,4533 ***	0,0890 *	0,0000	0,0890	540
	Denmark	0	0,4173 ***	0,0283 **	0,9329 ***	0,9612	540
	Sweden	1	0,6452 ***	0,0216 ***	0,9722 ***	0,9938	608
	Finland	1	0,7004 ***	0,0259 **	0,9636 ***	0,9895	608
	France	1	0,7500 ***	0,0229	0,9662 ***	0,9892	608
Developed Europe	Germany	1	0,7102 ***	0,0198 *	0,9706 ***	0,9904	608
	UK	1	0,7814 ***	0,0668 **	0,7928 ***	0,8595	608
	Spain	1	0,6974 ***	0,0344 ***	0,9342 ***	0,9686	608
	Denmark	1	0,6394 ***	0,0458 *	0,9056 ***	0,9513	608
	Sweden	1	0,4631 ***	0,0216 **	0,9447 ***	0,9663	610
	Finland	1	0,4633 ***	0,0208 *	0,9428 ***	0,9636	610
	France	1	0,4896 ***	0,0163	0,9048 ***	0,9211	610
Emerging Europe	Germany	1	0,4567 ***	0,0185 *	0,9460 ***	0,9645	610
	UK	1	0,4585 ***	0,0191	0,9390 ***	0,9581	610
	Spain	1	0,4787 ***	0,0020	0,7386 ***	0,7406	610
	Denmark	1	0,4221 ***	0,0187	0,9325 ***	0,9512	610

*, **, *** Indicate significance at 10%, 5% and 1% level respectively.

[a] Indicate presence of autocorrelation up to 5 lags.

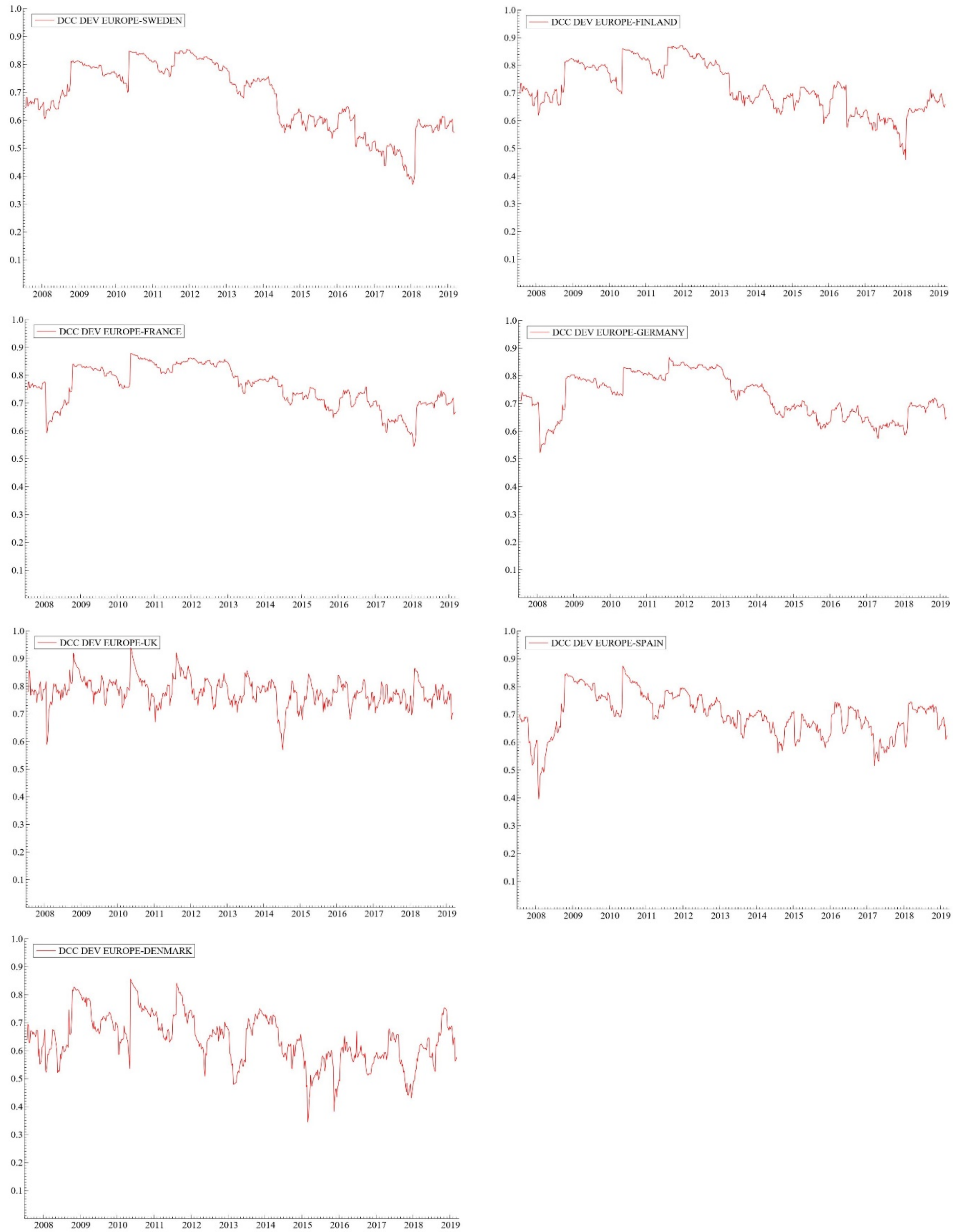
DCC-GARCH OUTPUT

Graph 5.1*a* US

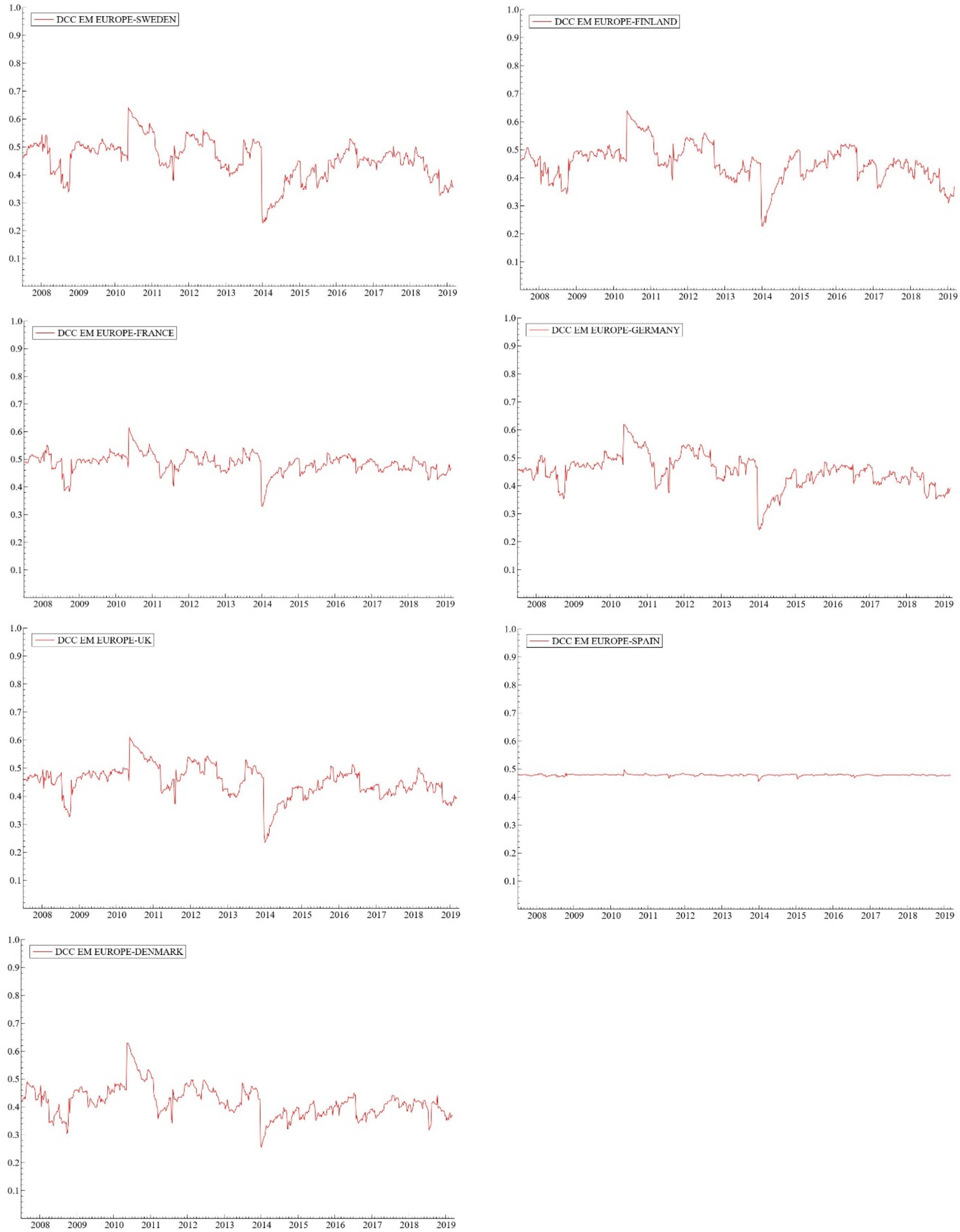
Graph 5.1*b* Developed Asia Pacific

Graph 5.1*c* Emerging Asia Pacific

Graph 5.1*d* Developed Europe



Graph 5.1*e* Emerging Europe



5.2.1. Diversification potential of developed REITs

Graph 5.1a – 5.1e generally display time-varying positive conditional correlations. This implies interdependence to some degree for the REIT-stock pairs. However, as the conditional correlations are less than unity, investors can benefit from some level of diversification in all combinations of REITs and stocks. Depending on the average level of the co-movements, the diversification potential varies between different asset pairs. Furthermore, the degree of volatility fluctuations has implications for the short-run diversification potential. Greater fluctuations imply lower predictability, making the short-run diversification potential less reliable. For investors with long investment horizons, great volatilities challenge their ability to hold a passive strategy through turbulent market conditions.

The mean reverting conditional correlation coefficient, $\bar{\rho}_{ij}$, in Table 5.3 works as an average measure of diversification in our pairwise DCC analysis. This part of the DCC provides information connected to the results from Johansen's cointegration by evaluating the level of diversification investors can expect in the long run. A high value of $\bar{\rho}_{ij}$ implies stronger average conditional correlation between an asset-pair, indicating greater average co-movements and smaller long-term diversification benefits. According to the average level of co-movements, we find that combinations of the European stocks and developed Europe REITs generate the strongest conditional correlations and the smallest diversification potential in the sample. This implies that investors with long investment horizons find greater diversification potential from combining European stocks with other REIT markets than developed Europe. These results are supported by the unconditional correlations in Table 4.6 and agree with the findings of Niskanen and Falkenbach (2010) concluding stronger correlations between European REITs and stocks than between European REITs and US or Asia Pacific stocks. Related to this finding, there is empirical evidence for non-existing or limited diversification possibilities between REITs and stocks within a country (Liow *et al*., 2009; Liow, 2010; Chang *et al*., 2015). As developed Europe correlate stronger with the European stocks than developed Asia Pacific and US, the within-country findings of limited diversification seem to apply for within-regional combinations of REITs and stocks as well. This interdependency could be explained by similar economic factors among the developed countries in Europe, making them respond similarly to shocks in the financial markets. Fei *et al*. (2010) suggest macroeconomic factors to explain high levels of conditional correlations between REITs and stocks within a country. Moreover, Liow and Ye (2018*a*) argue that European financial markets are integrated because of the similar regulations originating from the European Union institutional framework. Thus, macroeconomic factors stemming from the similarities due to membership of the European Union could possibly result in the convergence of the developed Europe REIT market and the European stock markets.

As the conditional correlations on average are lower for developed Asia Pacific and the US than for developed Europe we suggest private investors seeking long-term diversification to invest in cross-regional combinations of REITs and stocks rather than within-regional. Moreover, comparing the US and developed Asia Pacific output, we find the US combinations to generally exhibit lower levels of conditional correlations than the developed Asia Pacific combinations. However, the outputs of the US and developed Asia Pacific are volatile and fluctuate more than developed Europe. The high level of volatility fluctuations indicates high responsiveness to shocks which suggests uncertain implications of the short-run diversification. Previous studies finding volatility going from the US to the European securitized real estate markets (Liow and Ye, 2018*a*; Liow and Ye, 2018*b*) argue economic globalization and the recent financial crises to explain the volatile linkage (Liow and Ye, 2018*a*). Particularly, it is the increased synchronization of business cycles between the US and Europe that cause the spill over relation and explains the US fluctuations (Liow and Ye, 2018*b*). Regarding Asia Pacific, earlier studies suggest that the US and Asia Pacific REIT markets have become increasingly connected (Tsai and Lee, 2012; Chang and Chen, 2014) especially in the aftermath of the GFC (Liow and Ye, 2018*a*). Hence, for developed Asia Pacific, the great fluctuations might steam from the linkage to the US market. Moreover, the Asia Pacific region increasingly plays an important role in the global economy (Liow and Schindler, 2014), possibly connecting the region with Europe. According to Tsai (2013), developed REIT markets are more volatile as their corresponding financial markets often are developed and stronger integrated with the global financial market. The findings of Tsai (2013) result from a study of Japanese and Asian combinations of REITs and stocks. Since Japanese REITs constitute about 42 percent of the developed Asia Pacific index in our study, as displayed in Table 4.3, it might explain the conditional volatility in the developed Asia Pacific outputs. Additionally, the composition of the developed Asia Pacific REIT index, including real estate companies and not only REITs, might also explain the fluctuating co-movements in relation to the European stock indices.

Since the outputs of US and developed Asia Pacific are volatile and fluctuate, the diversification potential is less reliable in the short run. However, the long-run finding of no cointegration and decreased rather than increased average levels of conditional correlations indicate long-run diversification potential in line with Liow and Ye (2018*b*) who argue that increased investment horizons generally result in lower correlations between equities and securitized real estate.

5.2.2. Differences between emerging and developed REIT markets

Considering emerging markets, the average level of conditional correlations is generally lower for the emerging REIT markets than for their developed counterparts. This is supported by the unconditional correlations in Table 4.6. In contradiction, the cointegration results find no differences in long-run diversification potential between emerging and developed combinations of REITs and stocks. However, investigating the average level of conditional correlation enables ranking of the results from the cointegration analysis. On average, we find lower levels of co-movements for the emerging REIT outputs than their developed counterparts. This implies greater long-run diversification potential from combinations of European stocks and emerging REITs than developed REITs. The European stock markets included in this study are considered as mature (FTSE Russel, 2019) and as developed markets are more affected by financial integration (Donadelli and Paradiso, 2014) one might expect the developed European REITs to be closer connected to the stock markets than the emerging European REITs. Studies have found emerging and developed stock markets to be differently influenced by the global economy, with emerging markets affected by country-specific risk rather than global risk (Li and Majerowska, 2008). This implies emerging markets are less affected by financial integration (Donadelli and Paradiso, 2014). Similar characteristics are also found in emerging and developed housing markets (Haran et al., 2016). Our results are in line with these findings. In the long run, the DCC results of REIT-stock diversification suggest that emerging markets seem to follow other long-run trends than developed markets. Fei et al. (2010) suggests market co-movements can be explained by macroeconomic factors, and developed and emerging markets have different characteristics (Pham, 2012; Haran et al., 2016). Hence, the results from our study support the view of different macroeconomic factors affecting developed and emerging markets in the long run, and that the markets react differently to the same macroeconomic factors. However, these findings only seem to hold for the within-regional perspective. The US average conditional correlation coefficients are generally lower than for the emerging REIT-stock combinations. Hence, for private investors, our results indicate that the US REITs provide the best long-run diversification even when compared to emerging markets. A possible explanation to this is that the US REIT market is considered the most mature (EY, 2018). Hence, it is a well-functioning market in terms of liquidity and legislation, making access and trading easy for investors. Moreover, as displayed in Graph 2.1, the US REIT index sometimes provides greater returns than the average stock market, making US REITs attractive for investors.

Moreover, the magnitude of the volatility fluctuations has implications for short-run diversification. The DCC outputs for emerging Europe and developed Europe are less volatile than the US and developed Asia Pacific. For emerging Asia Pacific, there is a change in the volatility pattern in 2015 where increased fluctuations are observed in effect. Coën and Lecomte (2019) find a shift from local to global factors influencing the securitized real estate markets, including REITs, in the aftermath of the GFC. The shift to global factors affecting securitized real estate markets might explain the increased fluctuations for emerging Asia Pacific. For short investment horizons, absence of great fluctuations imply that private investors avoid continuously having to reallocate their portfolios. The implication of great or increased volatility is that investors cannot be certain of the short-run diversification outcome.

Hence, emerging and developed Europe can be argued as more stable alternatives for short-run diversification. However, the graphics of the REIT indices in level in Graph A.1 in the Appendix, display that the emerging Europe distinguish from the other REIT indices, in that it continuously decreases from the beginning of 2013. The constant negative trend explains the low correlations in relation to the European stocks, since the stock indices show positive trends in the post-crises period as exhibited in Graph A.2 in the Appendix. Thus, the emerging Europe REIT index cannot be considered attractive to private investors unless it also provides a shelter against financial turmoil. During the crises, the emerging Europe REIT index dropped, just as the stock market indices, and further research is required to determine the diversification potential of emerging REITs in stock portfolios during crises. Moreover, the level around which the conditional correlations fluctuate also matters for the short-run diversification. Although the developed Europe output display less fluctuations than the other developed REIT-stock pairs, it varies around a high average level of conditional correlations which is not preferred for diversification. Due to the absence of a distinct pattern in short-run fluctuations, we cannot find any short-term characteristics distinguishing emerging and developed REIT markets in relation to the European stock markets.

5.2.3. Diversification potential of REITs in times of crises

We find increased conditional correlations between the REIT-stock pairs during the GFC and the EDC in line with earlier studies (Hoesli and Kustrim, 2013; Milunovich and Trück, 2013) implying decreased diversification potential during this period.

Investigating the DCC outputs in Graph 5.1a – 5.1e, we find that the US exhibit moderate levels of conditional correlations during the GFC followed by a considerable increase during 2011, covering the EDC. The increased co-movements during the crises are explained by greater volatility spillover from the US to the European markets in this period (Zheng and Zuo, 2013; Liow and Ye, 2018*b*). However, in the post-crises period, the average conditional correlations decrease to low or sometimes even negative levels implying improved diversification potential in the aftermath of the crises. For developed Asia Pacific the conditional correlations are moderate to strong during the crises. This finding might be explained by the fact that the Asia Pacific REIT market became closer connected to the US REIT market during the GFC (Tsai and Lee, 2012; Chang and Chen, 2014). Consequently, as the GFC increased the interdependence between US, European and Asian stock markets (Zheng and Zuo, 2013) the Asia Pacific REIT market can be expected to be increasingly connected to the European stock market as well. However, in contradiction to the findings for the US REIT index, developed Asia Pacific does not significantly respond to the EDC, and from 2013 a downward shift in average conditional correlations for developed Asia Pacific is displayed. The conditional correlations begun to fluctuate around a lower mean than before. The downward shift, interpreted in terms of diversification, implies greater long-run diversification potential in the post-crises period than during the crises. The same kind of downward shift is displayed for emerging Europe, but the average level of the conditional correlations is generally lower than for the developed Asia Pacific. Developed Europe exhibit the strongest conditional correlations in the during-crises period. Although the conditional correlations for developed Europe remain strong or moderate in the post-crises period, the trend is decreasing average co-movements in the later part of the sample. Emerging Asia Pacific show a different pattern compared to the other REIT-stock combinations, with conditional correlations fluctuating around a downward sloping mean from 2009 to the middle of 2015. Thereafter, the volatility increases but stays around a constant mean.

As the results from the DCC outputs do not indicate any upward sloping trend in the conditional correlations, our findings contradict studies that conclude increased financial integration over time (Nikbakht *et al*., 2016; Liow and Ye, 2018*a*; Liow and Ye, 2018*b*). From our results we argue that financial integration between the investigated assets have not increased over the whole period studied. However, as greater co-movements generally are found in the during-crises period for the combinations of REITs and stocks, we support the idea of increased interdependence during the GFC (Hoesli and Kustrim, 2013; Milunovich and Trück, 2013). More particularly, we argue that if an event is closely connected to the real estate market, as in the case of the GFC (Liow and Ye, 2018*b*), the co-movements between REIT and stock markets can be expected to increase. This implies decreasing short-run diversification potential. Moreover, most of the combinations exhibit downward sloping trends or downward shifts in the mean around which the conditional correlations fluctuate, following the during-crises period. Generally, the decreased level of conditional correlations implies increased diversification potential from the combination of REITs and stocks in the long run. One potential explanation, which is also confirmed by our GC results, could be that the crises period was characterized by abnormal market conditions (Liow and Ye, 2014) that went back to normal in the post-crises period and resulted in decreased co-movements. Liow and Ye (2014) argue that the spillover effect between securitized real estate, including REITs, and stocks in times of crises depends on the source of the crises. Hence, investors can expect greater shelter from securitized real estate in financial turmoil that does not originate from or directly involve the real estate market. As REITs generally seem to work more efficiently as a diversification tool in stock portfolios in the post-crises period than in the during-crises period, we support the conclusion of Liow and Ye (2014) and emphasize that private investors should consider the market conditions when diversifying with REITs.

6. Conclusion

In this study we have examined the long- and short-run diversification potential of real estate investments with REITs for private investors holding European stocks during 2007 to 2019. The REIT markets included in this study are the US, Europe and Asia Pacific. By combining Johansen's cointegration, Granger non-causality and DCC-GARCH modelling, we fill the research gap of the international diversification potential of REITs. Moreover, we find that combining a cointegration approach with DCC analysis is useful for long-term investors when setting up or evaluating passive investment strategies since it assists in ranking different long-term investment options.

Our results suggest that international long- and short-run diversification is possible by combining REITs and stocks both during and after the crises for all REIT markets examined. However, the diversification potential of some combinations is better than others. In the long run, cross-regional diversification offers better diversification potential than within-regional diversification for the European stock indices. In the short run, the diversification potential between the REIT-stock pairs is time-varying. This makes short-run diversification less reliable, hence investors with short-term investment horizons must continuously reallocate their portfolios. In general, we find that changes in stock market returns lead changes in REIT market returns. This mechanism can assist short-term investors in the reallocation process. Long-term investors however may hold their portfolios and disregard the short-term characteristics due to the absence of cointegration.

Moreover, there is diversification potential for both emerging and developed REIT markets. The average levels of conditional correlations are generally lower for the emerging REIT markets than for their developed counterparts implying that within a region, the emerging market is preferred over the developed market for long-run diversification. However, this result only holds for the within-regional perspective. The US generally exhibit the lowest average conditional correlations among the REIT-stock pairs, making this developed market the best diversification option among the REIT markets studied. In the short run however, no distinct pattern is distinguished between emerging and developed REIT markets, hence we cannot tell in what way the short-run diversification potential differs between them.

The lesson learned from the GFC and EDC is that portfolio behavior significantly changes due to changed market characteristics. We find increased interdependence between the REIT-stock pairs during the crises, confirming abnormal market conditions and decreased diversification potential. However, this only affects short-term investors since over the whole sample there is no trend of increased interdependence between the examined markets. Hence, our findings suggest the markets recover in the post-crises period implying that REITs continue to provide a good diversification tool for private investors holding European stocks.

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Appendix

Table A.1 ADF During-Crises

Index (log)	Null Hypothesis	Lag	AIC	ADF-statistic	P-value	Result	Conclusion
Stock							
Sweden	I(2) T+C	1	-3,0333	-10,8406	0,0000	Reject	Series is I(1)
	I(1) T+C	1	-3,0533	-1,9432	0,6285	Accept	
Finland	I(2) T+C	1	-3,1280	-10,5774	0,0000	Reject	Series is I(1)
	I(1) T+C	1	-3,1409	-1,6065	0,7878	Accept	
France	I(2) T+C	1	-3,1749	-10,6978	0,0000	Reject	Series is I(1)
	I(1) T+C	1	-3,1948	-1,9803	0,6086	Accept	
Germany	I(2) T+C	1	-3,2008	-1,8681	0,6678	Reject	Series is I(1)
	I(1) T+C	1	-3,2093	-1,9133	0,3258	Accept	
UK	I(2) T+C	1	-3,4133	-10,9884	0,0000	Reject	Series is I(1)
	I(1) T+C	2	-3,4176	-1,7176	0,7406	Accept	
Spain	I(2) T+C	1	-3,0821	-10,7105	0,0000	Reject	Series is I(1)
	I(1) T+C	1	-3,1005	-1,9571	0,6211	Accept	
Denmark	I(2) T+C	2	-3,2771	-8,1933	0,0000	Reject	Series is I(1)
	I(1) T+C	3	-3,2813	-1,7238	0,7377	Accept	
REIT							
US	I(2) T+C	1	-2,8962	-10,9844	0,0000	Reject	Series is I(1)
	I(1) T+C	1	-2,9132	-1,7531	0,7242	Accept	
Developed Asia Pacific	I(2) T+C	1	-3,3258	-10,3370	0,0000	Reject	Series is I(1)
	I(1) T+C	1	-3,3358	-1,5955	0,7922	Accept	
Emerging Asia Pacific	I(2) T+C	4	-3,5210	-5,9808	0,0000	Reject	Series is I(1)
	I(1) T+C	4	-3,5499	-2,1979	0,4871	Accept	
Developed Europe	I(2) T+C	2	-3,0901	-8,4256	0,0000	Reject	Series is I(1)
	I(1) T+C	1	-3,1039	-1,8236	0,6902	Accept	
Emerging Europe	I(2) T+C	3	-2,5191	-5,9767	0,0000	Reject	Series is I(1)
	I(1) T+C	4	-2,5313	-2,1695	0,5038	Accept	

The critical value for the ADF-test with trend and intercept is -3,42 for samples of 500 observations, -3,43 for samples of 250 observations and -3,45 for samples of 100 observations.

The critical value for the ADF-test without trend but with intercept is -2,87 for samples of 500 observations, -2,88 for samples of 250 observations and -2,89 for samples of 100 observations.

If the ADF-statistic from the unit root tests are more negative than the critical value the null hypothesis is rejected, which is indicated by a significant p-value. The more negative, the stronger the rejection of the null hypothesis of a unit root.

T+C indicates the testing procedure includes both trend and constant.

C indicated the testing procedure includes only the constant.

Table A.2 ADF Post-Crises

Index (log)	Null Hypothesis	Lag	AIC	ADF-statistic	P-value	Result	Conclusion
Stock							
Sweden	I(2) T+C	4	-4,5545	-9,0656	0,0000	Reject	Series is I(1)
	I(1) T+C	5	-4,5617	-2,1421	0,5199	Accept	
Finland	I(2) T+C	4	-4,5364	-8,4676	0,0000	Reject	Series is I(1)
	I(1) T+C	5	-4,5455	-2,3019	0,4314	Accept	
France	I(2) T+C	2	-4,6664	-12,3811	0,0000	Reject	Series is I(1)
	I(1) T+C	3	-4,6729	-2,0906	0,5489	Accept	
Germany	I(2) T+C	2	-4,5909	-12,2746	0,0000	Reject	Series is I(1)
	I(1) T+C	3	-4,5957	-1,9362	0,6334	Accept	
UK	I(2) T+C	4	-4,5970	-9,3192	0,0000	Reject	Series is I(1)
	I(1) T+C	3	-4,9709	-2,2136	0,4801	Accept	
Spain	I(2) T+C	3	-4,1782	-10,2878	0,0000	Reject	Series is I(1)
	I(1) T+C	2	-4,1867	-2,0643	0,5635	Accept	
Denmark	I(2) T+C	4	-4,7417	-8,2689	0,0000	Reject	Series is I(1)
	I(1) T+C	5	-4,7465	-1,9260	0,6388	Accept	
REIT							
US	I(2) T+C	1	-4,9837	-14,6107	0,0000	Reject	Series is I(1)
	I(1) T+C	1	-5,0197	-3,9078	0,0126	Reject	
	I(1) C	1	-4,9977	-2,3010	0,1722	Accept	
Developed Asia Pacific	I(2) T+C	2	-5,1513	-11,3420	0,0000	Reject	Series is I(1)
	I(1) T+C	3	-5,1718	-3,0971	0,1085	Accept	
Emerging Asia Pacific	I(2) T+C	1	-4,1683	-13,1615	0,0000	Reject	Series is I(1)
	I(1) T+C	1	-4,1803	-2,3883	0,3850	Accept	
Developed Europe	I(2) T+C	2	-4,7830	-12,2680	0,0000	Reject	Series is I(1)
	I(1) T+C	3	-4,7880	-1,9520	0,6249	Accept	
Emerging Europe	I(2) T+C	3	-3,4688	-10,4159	0,0000	Reject	Series is I(1)
	I(1) T+C	1	-3,4839	-3,3958	0,0535	Accept	

The critical value for the ADF-test with trend and intercept is -3,42 for samples of 500 observations, -3,43 for samples of 250 observations and -3,45 for samples of 100 observations.

The critical value for the ADF-test without trend but with intercept is -2,87 for samples of 500 observations, -2,88 for samples of 250 observations and -2,89 for samples of 100 observations.

If the ADF-statistic from the unit root tests are more negative than the critical value the null hypothesis is rejected, which is indicated by a significant p-value. The more negative, the stronger the rejection of the null hypothesis of a unit root.

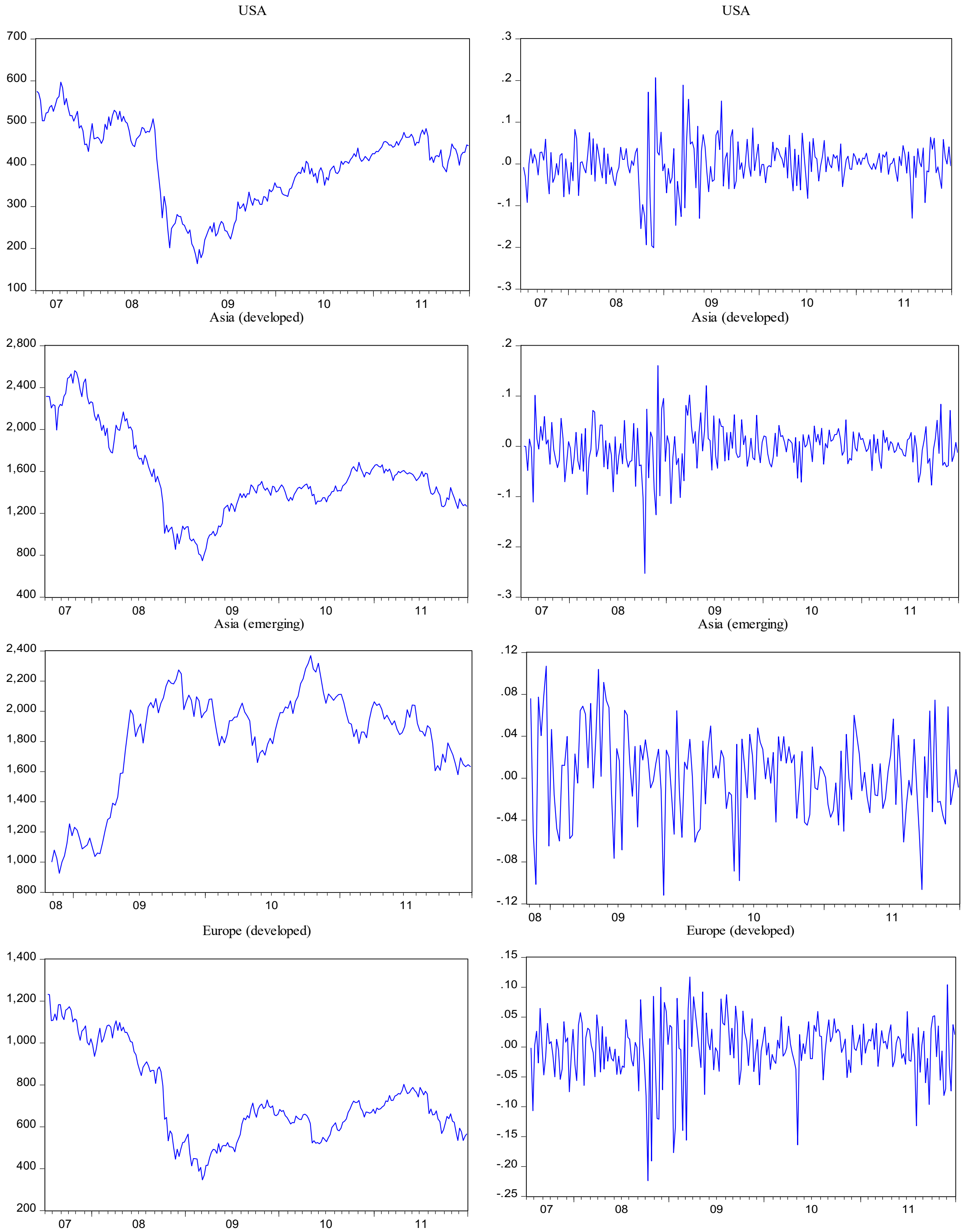
T+C indicates the testing procedure includes both trend and constant.

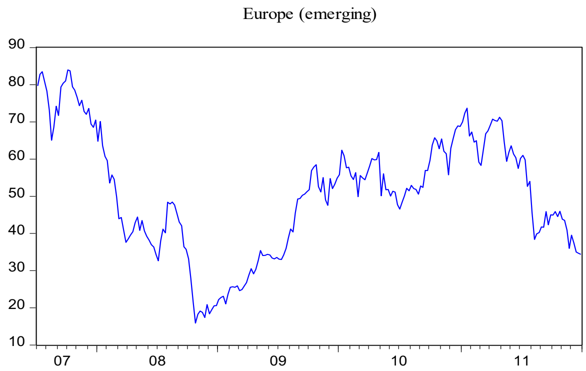
C indicated the testing procedure includes only the constant.

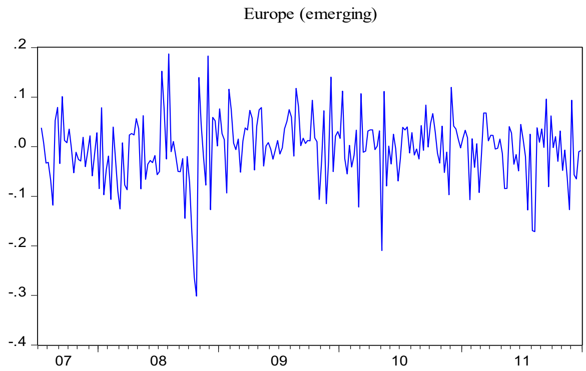
Graph A.1

REITs
During-Crises

Level | Logarithmic I(1)



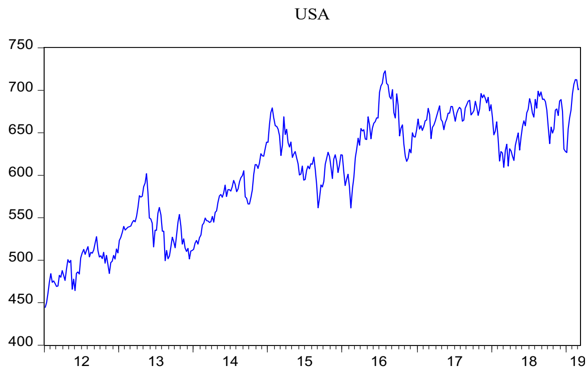


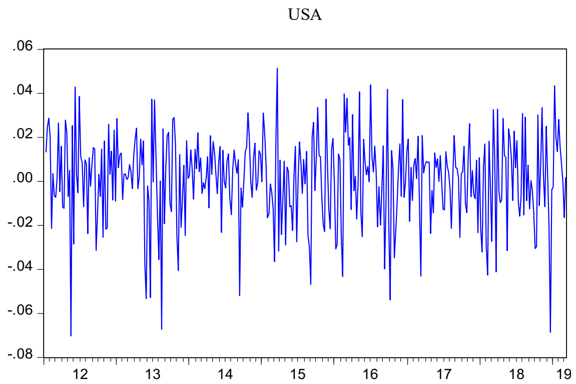


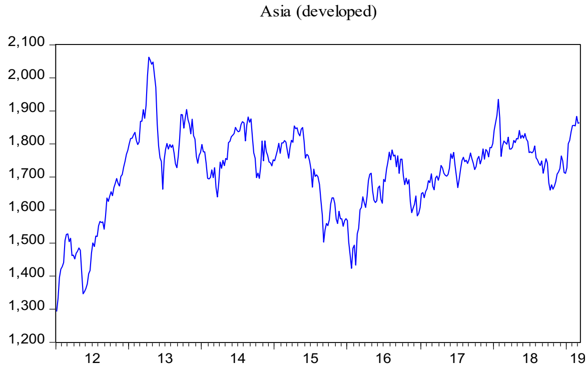
Post-Crises

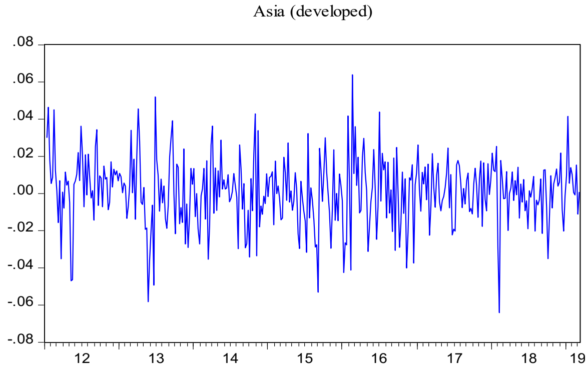
Level

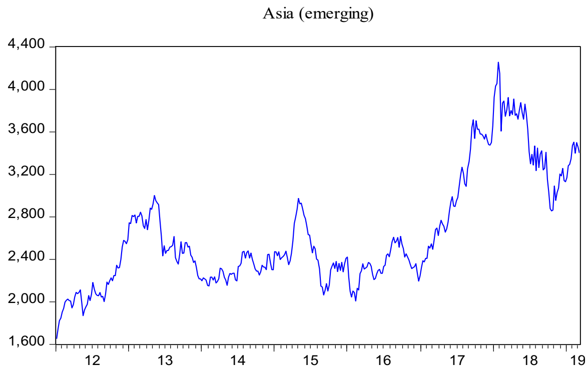
Logarithmic I(1)

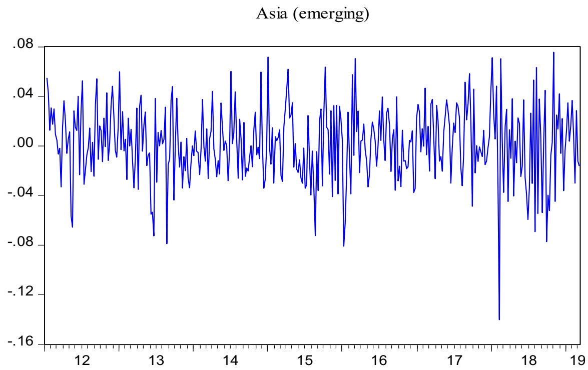


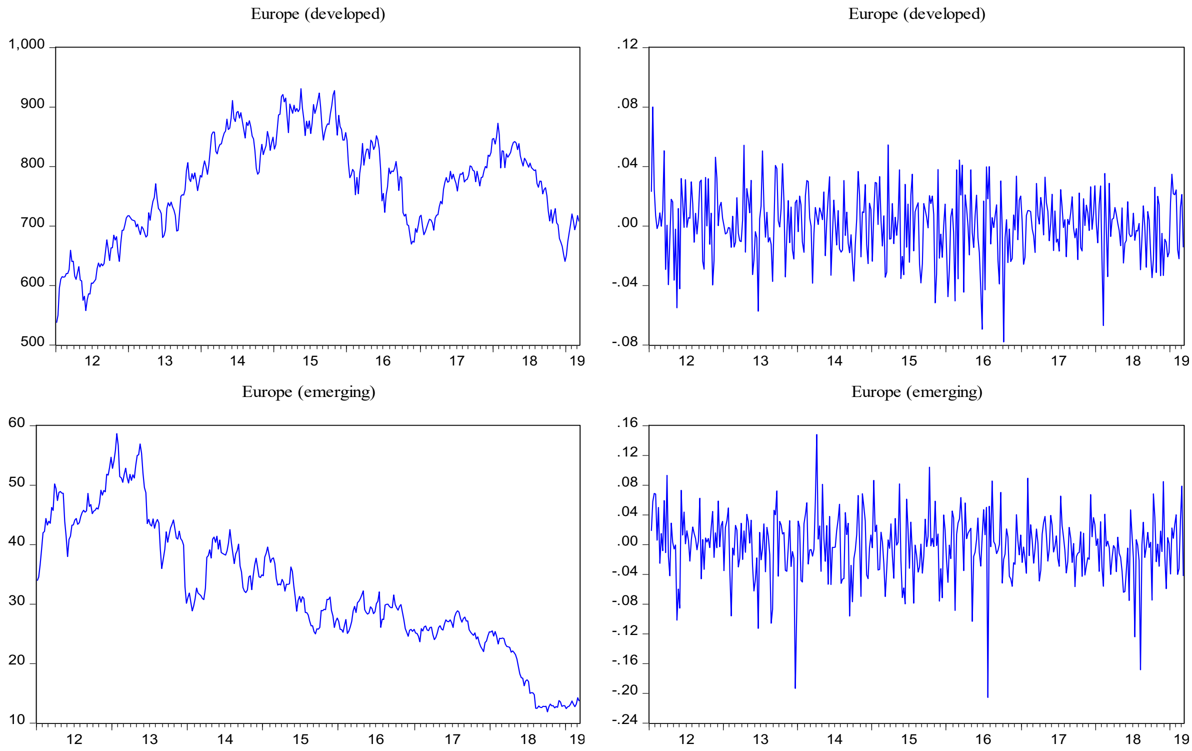











Europe (developed)
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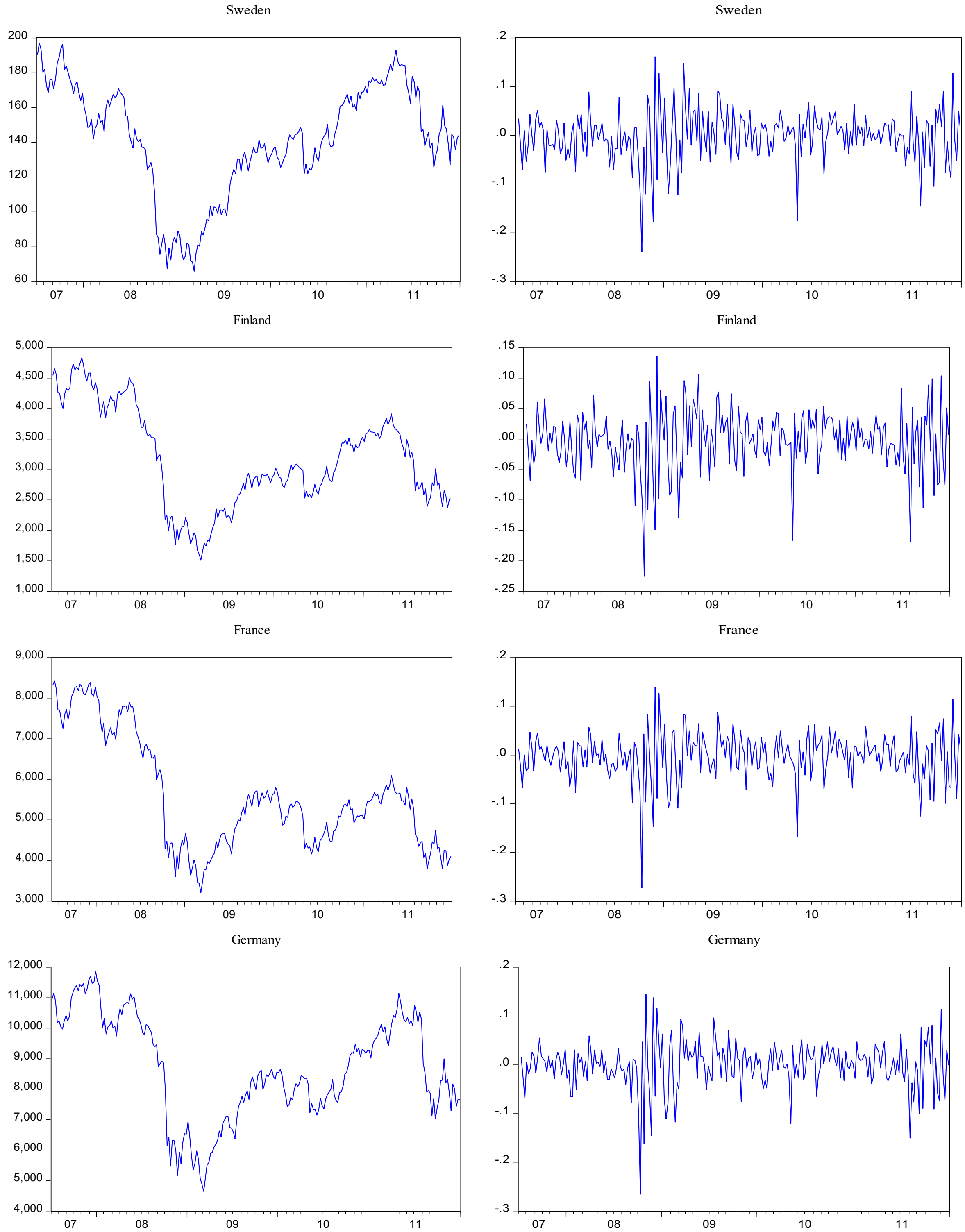
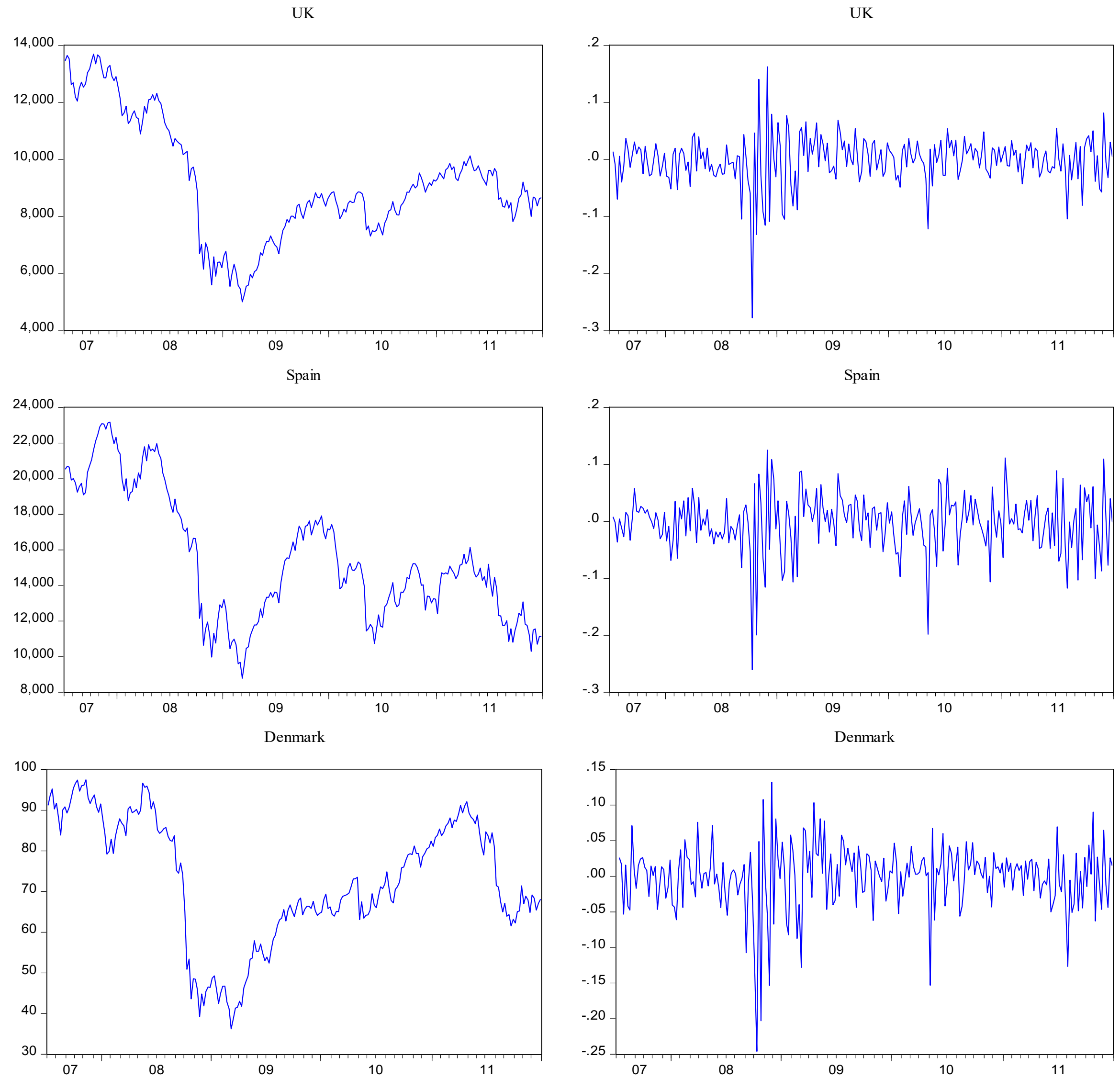
Graph A.2

STOCKS
During-Crises

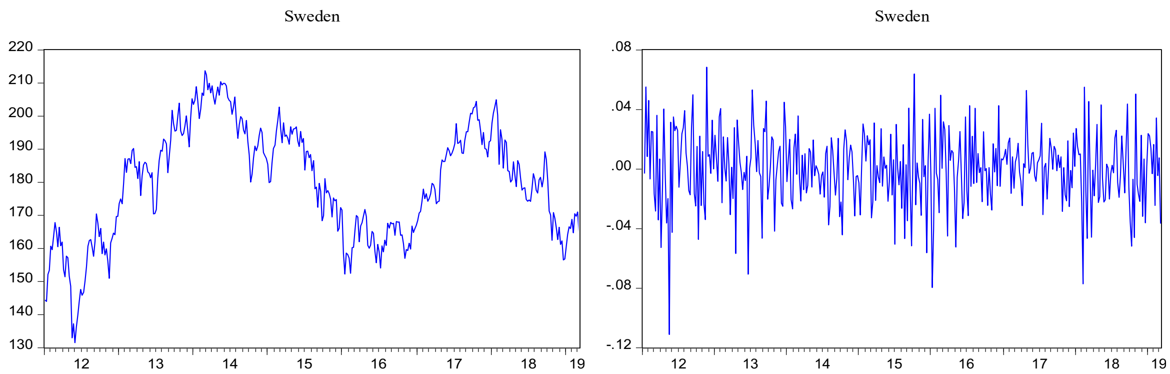
Level | Logarithmic I(1)

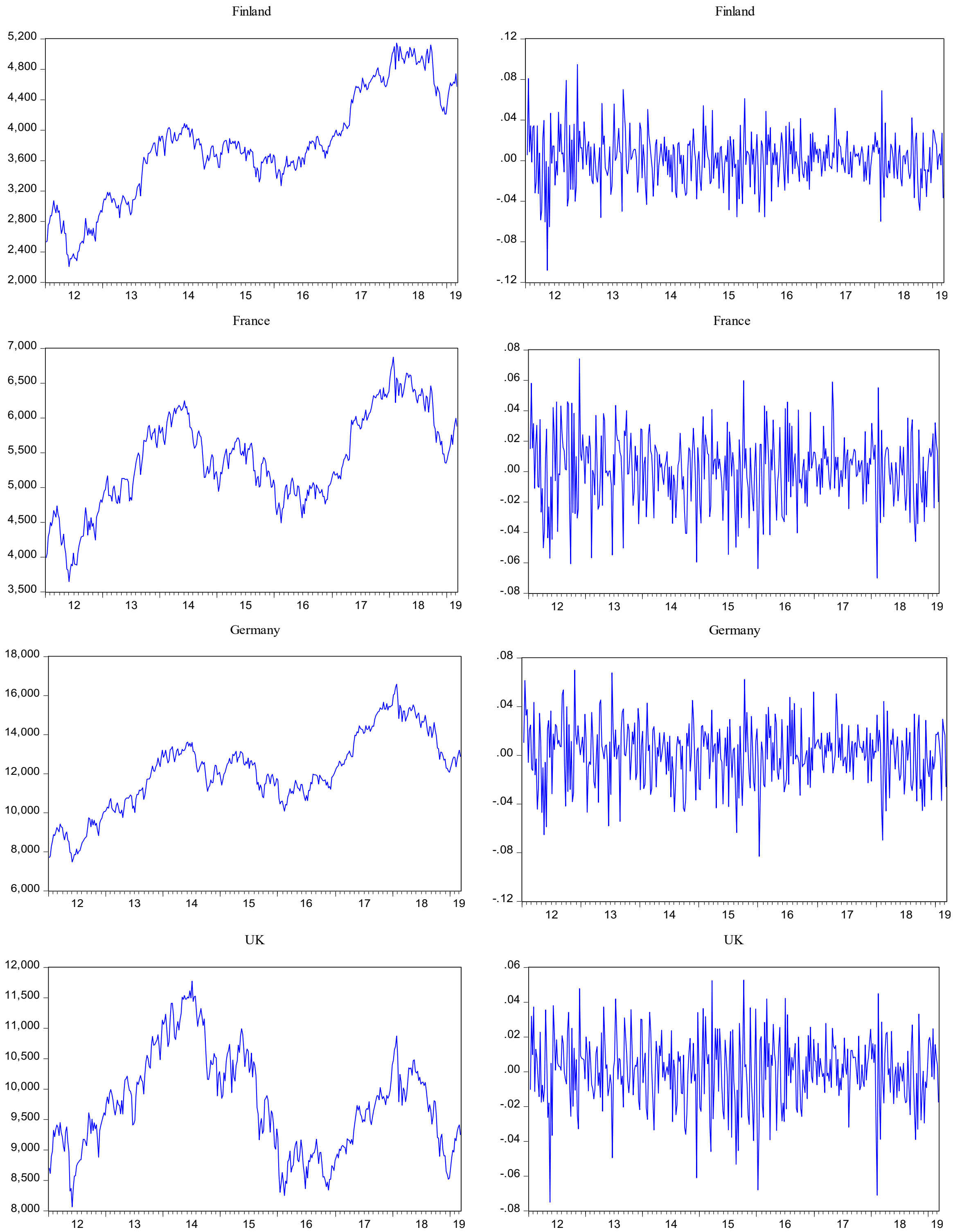




Post-Crises

Level | Logarithmic I(1)




Finland
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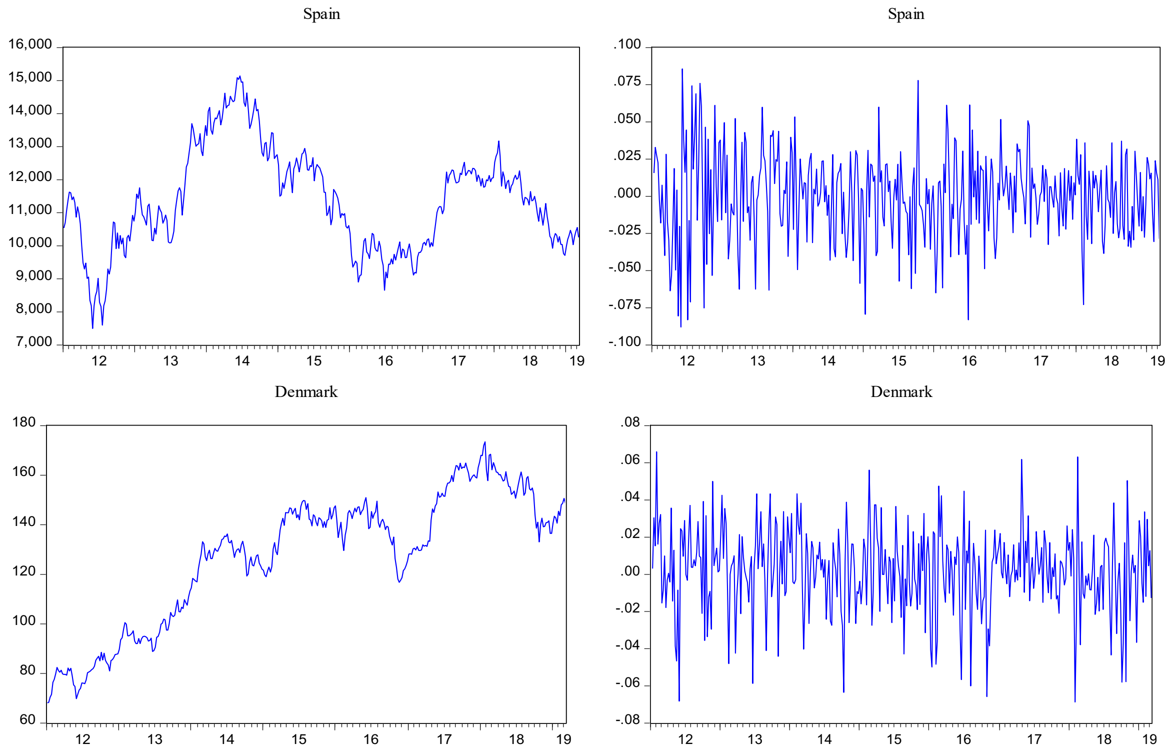
4,800
4,400
4,000
3,600
3,200
2,800
2,400
2,000
12 13 14 15 16 17 18 19
Finland
.12
.08
.04
.00
-.04
-.08
-.12
12 13 14 15 16 17 18 19
France
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
12 13 14 15 16 17 18 19
France
.08
.06
.04
.02
.00
-.02
-.04
-.06
-.08
12 13 14 15 16 17 18 19
Germany
18,000
16,000
14,000
12,000
10,000
8,000
6,000
12 13 14 15 16 17 18 19
Germany
.08
.04
.00
-.04
-.08
-.12
12 13 14 15 16 17 18 19
UK
12,000
11,500
11,000
10,500
10,000
9,500
9,000
8,500
8,000
12 13 14 15 16 17 18 19
UK
.06
.04
.02
.00
-.02
-.04
-.06
-.08
12 13 14 15 16 17 18 19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7,000
12
13
14
15
16
17
18
19
Spain
.100
.075
.050
.025
.000
-.025
-.050
-.075
-.100
12
13
14
15
16
17
18
19
Denmark
180
160
140
120
100
80
60
12
13
14
15
16
17
18
19
Denmark
.08
.06
.04
.02
.00
-.02
-.04
-.06
-.08
12
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15
16
17
18
19

Table A.3

Granger non-causality During-Crises

REIT index	Stock index	Null hypothesis	VAR/VEC	P-value	Result	Conclusion
US	Sweden	US does not Granger Cause SWE	VEC	0,0122	Reject	SWEDEN ← US
		SWE does not Granger Cause US		0,2611	Accept	
	Finland	US does not Granger Cause FIN	VAR	0,0249	Reject	FINLAND ↔ US
		FIN does not Granger Cause US		0,0149	Reject	
	France	US does not Granger Cause FRA	VAR	0,2471	Accept	-
		FRA does not Granger Cause US		0,1438	Accept	
	Germany	US does not Granger Cause GER	VAR	0,1456	Accept	GERMANY → US
		GER does not Granger Cause US		0,0342	Reject	
	UK	US does not Granger Cause UK	VAR	0,0182	Reject	UK ↔ US
		UK does not Granger Cause US		0,0475	Reject	
	Spain	US does not Granger Cause SPA	VAR	0,0084	Reject	SPAIN ← US
		SPA does not Granger Cause US		0,0735	Accept	
	Denmark	US does not Granger Cause DEN	VAR	0,0025	Reject	DENMARK ↔ US
		DEN does not Granger Cause US		0,0123	Reject	
Developed Asia Pacific	Sweden	DEV APAC does not Granger Cause SWE	VAR	0,0729	Accept	-
		SWE does not Granger Cause DEV APAC		0,7024	Accept	
	Finland	DEV APAC does not Granger Cause FIN	VAR	0,1101	Accept	-
		FIN does not Granger Cause DEV APAC		0,3639	Accept	
	France	DEV APAC does not Granger Cause FRA	VAR	0,3907	Accept	-
		FRA does not Granger Cause DEV APAC		0,4684	Accept	
	Germany	DEV APAC does not Granger Cause GER	VAR	0,1193	Accept	-
		GER does not Granger Cause DEV APAC		0,1201	Accept	
	UK	DEV APAC does not Granger Cause UK	VAR	0,0015	Reject	UK ← DEV APAC
		UK does not Granger Cause DEV APAC		0,2874	Accept	
	Spain	DEV APAC does not Granger Cause SPA	VAR	0,0579	Accept	-
		SPA does not Granger Cause DEV APAC		0,4546	Accept	
	Denmark	DEV APAC does not Granger Cause DEN	VAR	0,0035	Reject	DENMARK ← DEV APAC
		DEN does not Granger Cause DEV APAC		0,4272	Accept	
Emerging Asia Pacific	Sweden	EM APAC does not Granger Cause SWE	VAR	0,0986	Accept	-
		SWE does not Granger Cause EM APAC		0,0757	Accept	
	Finland	EM APAC does not Granger Cause FIN	VAR	0,0576	Accept	-
		FIN does not Granger Cause EM APAC		0,4533	Accept	

Emerging Asia Pacific (continued)	France	EM APAC does not Granger Cause FRA	VAR	0,4941	Accept	FRANCE → EM APAC
		FRA does not Granger Cause EM APAC		0,0360	Reject	
	Germany	EM APAC does not Granger Cause GER	VAR	0,2966	Accept	-
		GER does not Granger Cause EM APAC		0,0839	Accept	
	UK	EM APAC does not Granger Cause UK	VAR	0,0619	Accept	UK → EM APAC
		UK does not Granger Cause EM APAC		0,0223	Reject	
	Spain	EM APAC does not Granger Cause SPA	VAR	0,3294	Accept	SPAIN → EM APAC
		SPA does not Granger Cause EM APAC		0,0066	Reject	
	Denmark	EM APAC does not Granger Cause DEN	VAR	0,0611	Accept	-
		DEN does not Granger Cause EM APAC		0,0945	Accept	
Developed Europe	Sweden	DEV EUR does not Granger Cause SWE	VAR	0,0780	Accept	-
		SWE does not Granger Cause DEV EUR		0,3095	Accept	
	Finland	DEV EUR does not Granger Cause FIN	VAR	0,2890	Accept	-
		FIN does not Granger Cause DEV EUR		0,0787	Accept	
	France	DEV EUR does not Granger Cause FRA	VAR	0,9003	Accept	-
		FRA does not Granger Cause DEV EUR		0,3268	Accept	
	Germany	DEV EUR does not Granger Cause GER	VAR	0,7979	Accept	-
		GER does not Granger Cause DEV EUR		0,3413	Accept	
	UK	DEV EUR does not Granger Cause UK	VAR	0,6150	Accept	-
		UK does not Granger Cause DEV EUR		0,1621	Accept	
	Spain	DEV EUR does not Granger Cause SPA	VAR	0,7772	Accept	-
		SPA does not Granger Cause DEV EUR		0,1223	Accept	
	Denmark	DEV EUR does not Granger Cause DEN	VAR	0,3402	Accept	-
		DEN does not Granger Cause DEV EUR		0,1729	Accept	
Emerging Europe	Sweden	EM EUR does not Granger Cause SWE	VAR	0,8772	Accept	SWEDEN → EM EUR
		SWE does not Granger Cause EM EUR		0,0279	Reject	
	Finland	EM EUR does not Granger Cause FIN	VAR	0,6583	Accept	FINLAND → EM EUR
		FIN does not Granger Cause EM EUR		0,0024	Reject	
	France	EM EUR does not Granger Cause FRA	VAR	0,7737	Accept	FRANCE → EM EUR
		FRA does not Granger Cause EM EUR		0,0111	Reject	
	Germany	EM EUR does not Granger Cause GER	VAR	0,0336	Reject	GERMANY ↔ EM EUR
		GER does not Granger Cause EM EUR		0,0047	Reject	
	UK	EM EUR does not Granger Cause UK	VAR	0,0237	Reject	UK ↔ EM EUR
		UK does not Granger Cause EM EUR		0,0156	Reject	
	Spain	EM EUR does not Granger Cause SPA	VAR	0,9642	Accept	SPAIN → EM EUR
		SPA does not Granger Cause EM EUR		0,0240	Reject	
	Denmark	EM EUR does not Granger Cause DEN	VAR	0,5054	Accept	DENMARK → EM EUR
		DEN does not Granger Cause EM EUR		0,0072	Reject	

Table A.4

Granger non-causality Post-Crises

REIT index	Stock index	Null hypothesis	VAR/VEC	P-value	Result	Conclusion
US	Sweden	US does not Granger Cause SWE	VAR	0,6453	Accept	-
		SWE does not Granger Cause US		0,2226	Accept	
	Finland	US does not Granger Cause FIN	VAR	0,6698	Accept	FINLAND → US
		FIN does not Granger Cause US		0,0105	Reject	
	France	US does not Granger Cause FRA	VAR	0,5055	Accept	-
		FRA does not Granger Cause US		0,0581	Accept	
	Germany	US does not Granger Cause GER	VAR	0,2242	Accept	-
		GER does not Granger Cause US		0,1222	Accept	
	UK	US does not Granger Cause UK	VAR	0,9694	Accept	-
		UK does not Granger Cause US		0,0808	Accept	
	Spain	US does not Granger Cause SPA	VAR	0,6953	Accept	SPAIN → US
		SPA does not Granger Cause US		0,0053	Reject	
	Denmark	US does not Granger Cause DEN	VAR	0,0616	Accept	DENMARK → US
		DEN does not Granger Cause US		0,0262	Reject	
Developed Asia Pacific	Sweden	DEV APAC does not Granger Cause SWE	VAR	0,1744	Accept	SWEDEN → DEV APAC
		SWE does not Granger Cause DEV APAC		0,0262	Reject	
	Finland	DEV APAC does not Granger Cause FIN	VEC	0,1967	Accept	FINLAND → DEV APAC
		FIN does not Granger Cause DEV APAC		0,0284	Reject	
	France	DEV APAC does not Granger Cause FRA	VAR	0,1682	Accept	FRANCE → DEV APAC
		FRA does not Granger Cause DEV APAC		0,0192	Reject	
	Germany	DEV APAC does not Granger Cause GER	VAR	0,0603	Accept	GERMANY → DEV APAC
		GER does not Granger Cause DEV APAC		0,0114	Reject	
	UK	DEV APAC does not Granger Cause UK	VAR	0,1269	Accept	-
		UK does not Granger Cause DEV APAC		0,1121	Accept	
	Spain	DEV APAC does not Granger Cause SPA	VEC	0,4042	Accept	SPAIN → DEV APAC
		SPA does not Granger Cause DEV APAC		0,0223	Reject	
	Denmark	DEV APAC does not Granger Cause DEN	VAR	0,0755	Accept	DENMARK → DEV APAC
		DEN does not Granger Cause DEV APAC		0,0033	Reject	
Emerging Asia Pacific	Sweden	EM APAC does not Granger Cause SWE	VAR	0,7108	Accept	-
		SWE does not Granger Cause EM APAC		0,5452	Accept	
	Finland	EM APAC does not Granger Cause FIN	VAR	0,3025	Accept	-
		FIN does not Granger Cause EM APAC		0,0931	Accept	
	France	EM APAC does not Granger Cause FRA	VAR	0,0625	Accept	FRANCE → EM APAC
		FRA does not Granger Cause EM APAC		0,0130	Reject	

Emerging Asia Pacific (continued)	Germany	EM APAC does not Granger Cause GER	VAR	0,0523	Accept	GERMANY → EM APAC
		GER does not Granger Cause EM APAC		0,0210	Reject	
	UK	EM APAC does not Granger Cause UK	VAR	0,8212	Accept	-
		UK does not Granger Cause EM APAC		0,1108	Accept	
	Spain	EM APAC does not Granger Cause SPA	VAR	0,4299	Accept	SPAIN → EM APAC
		SPA does not Granger Cause EM APAC		0,0401	Reject	
	Denmark	EM APAC does not Granger Cause DEN	VAR	0,0824	Accept	-
		DEN does not Granger Cause EM APAC		0,1397	Accept	
Developed Europe	Sweden	DEV EUR does not Granger Cause SWE	VAR	0,8587	Accept	-
		SWE does not Granger Cause DEV EUR		0,1141	Accept	
	Finland	DEV EUR does not Granger Cause FIN	VAR	0,7430	Accept	-
		FIN does not Granger Cause DEV EUR		0,7987	Accept	
	France	DEV EUR does not Granger Cause FRA	VAR	0,7610	Accept	-
		FRA does not Granger Cause DEV EUR		0,5665	Accept	
	Germany	DEV EUR does not Granger Cause GER	VAR	0,5809	Accept	-
		GER does not Granger Cause DEV EUR		0,2739	Accept	
	UK	DEV EUR does not Granger Cause UK	VAR	0,2328	Accept	-
		UK does not Granger Cause DEV EUR		0,2027	Accept	
	Spain	DEV EUR does not Granger Cause SPA	VAR	0,9429	Accept	-
		SPA does not Granger Cause DEV EUR		0,0823	Accept	
	Denmark	DEV EUR does not Granger Cause DEN	VAR	0,0341	Reject	DENMARK ↔ DEV EUR
		DEN does not Granger Cause DEV EUR		0,0170	Reject	
Emerging Europe	Sweden	EM EUR does not Granger Cause SWE	VAR	0,5198	Accept	-
		SWE does not Granger Cause EM EUR		0,0606	Accept	
	Finland	EM EUR does not Granger Cause FIN	VAR	0,5294	Accept	-
		FIN does not Granger Cause EM EUR		0,3130	Accept	
	France	EM EUR does not Granger Cause FRA	VAR	0,7695	Accept	-
		FRA does not Granger Cause EM EUR		0,3180	Accept	
	Germany	EM EUR does not Granger Cause GER	VAR	0,1173	Accept	-
		GER does not Granger Cause EM EUR		0,3504	Accept	
	UK	EM EUR does not Granger Cause UK	VAR	0,6535	Accept	-
		UK does not Granger Cause EM EUR		0,6874	Accept	
	Spain	EM EUR does not Granger Cause SPA	VAR	0,1751	Accept	-
		SPA does not Granger Cause EM EUR		0,6412	Accept	
	Denmark	EM EUR does not Granger Cause DEN	VAR	0,1280	Accept	-
		DEN does not Granger Cause EM EUR		0,4749	Accept	