ERASMUS UNIVERSITEIT ROTTERDAM

Master thesis

"Explaining cross-asset contagion"

Cross-asset contagion in the market for real estate.

Name:	Otto Hansen
Student number:	289204
MSc. Program:	Financial Economics
E-mail:	otto_hansen85@hotmail.com
Supervisor:	Drs. A. Markiewicz
Date:	31-03-2014

Preface

I wrote this thesis as a final stage of my financial economics master at the Erasmus University Rotterdam School of Economics. The topic regards contagion effects between the common stock market and the market for real estate. I chose this specific topic because the relationship between these two important markets interests me. Firstly, because both common stock and real estate assets are two important asset classes that make up the majority part of most investment portfolios. Secondly, because real estate is an asset class that is often regarded as a risk reducing instrument which specifically makes it an interesting asset class to study.
I am convinced that a better understanding of the linkages between the common stock market and the market for real estate enables investment managers to make better investment allocation decisions in the future and can therefore improve investment performance.

During the writing of this thesis I experienced trouble in the form of a severe depression which I finally overcame but that delayed my graduation.

Otto Hansen

Table of contents

Executive summary

The thesis addresses the relationship between the common stock market and the market for real estate in times of economic instability. Special attention is given to the change in this relationship caused by economic crisis. In much of the literature real estate is considered a safe haven asset class since in times of turbulence its value remains stable. Real estate is therefore added to most investment portfolio`s to diminish the risk profile of the investment portfolio in question.
Because of the importance of risk reduction in investment theory, I want to test whether or not the notion of real estate being a safe haven in times of crisis is still correct and to what extent.

The outcomes of this research can help investors make better investment decisions in the future and will hopefully in such a way achieve an economic utility increase.

By examining data on both common stock and real estate funds for four countries selected for research, the thesis tries to answer the main research question, which is formulated as:

"Is financial contagion occurring between the common stock market and the market for real estate in times of financial distress and if yes, to what degree?"

This main research question is for reasons of effective research in a second step divided in three different sub questions:

Sub question 1: To what extent is the correlation coefficient between the market for common stock and the market for real estate changed when a stable period due to an economic event transcends into an unstable period?

Sub question 2: To what extent is the volatility of returns for both the common stock market and the market for real estate changed when a stable period due to an economic event transcends into an unstable period?

Sub question 3: To what extend is the correlation coefficient between the common stock market and the market for real estate changed in times of economic crisis taking into account the effect of a changed volatility of the common stock market?

The research focuses on the timeframe 1990 to 2012. Data concerning the common stock market and the real estate market in the form of REITS (Real Estate Investment Trusts) are extracted from DataStream and used to give an answer to the three sub research questions formulated. Together, they will lead to the answering of the main research question. In this way, the occurrence of financial contagion is being put to the test and I can judge whether or not the notion of real estate being a safe haven asset class needs to be nuanced.

Results indicate that in times of crisis there is an increased co-movement between the common stock market and the market for real estate. This increased covariance during instable periods indicates that contagion effects between the common stock market and the real estate market do occur and therefore the notion of real estate being a safe haven asset class needs to be nuanced.

This research highlights that adding real estate to an investment portfolio for risk reducing purposes may not always necessarily lead to an actual risk reduction.
It points out that investment managers need to be aware of the fact that adding real estate to any investment portfolio may not necessarily lead to the desired risk reducing effect that is desired, because of increased correlation between the common stock market and the market for real estate in times of economic turbulence. The increased correlation coefficient causes an investment portfolio to experience a higher risk profile in times of economic turbulence than might have been foreseen. Therefore, I recommend investment managers to be skeptical about the risk reducing potential of real estate as an asset class and would like to advise them to search for other forms of risk reducing asset classes that together with real estate can protect an investment portfolio against a big value decrease in times of economic instability.

1. Introduction

This thesis addresses the subject of financial contagion. The specific goal of the writing of this thesis is to find out whether or not the notion of real estate being a safe haven in times of financial crises is correct and to what extend it holds given changed interdependencies between the common stock market and the market for real estate in times of economic crisis.

1.1 Reasons to investigate

Often it is assumed in economic literature that real estate is successful in reducing a portfolio`s risk profile whilst being able to maintain a certain rate of return level. Or stated differently, that adding real estate funds to a portfolio enables the investor to increase the expected return of the portfolio without increasing its risk profile.
The reason for me to investigate the interdependencies between the common stock market and the market for real estate is because I think this notion should be nuanced. I can think of several reasons why:

- I expect that the market for real estate and the common stock market have gotten more intertwined throughout time.
- I am convinced that the sentiment of traders and their irrational behavior during times of crisis may have a negative impact on the risk reducing potential of real estate as an asset class.
- I expect that the characteristics of open market trading of real estate have an impact on the risk reducing potential of real estate.

1.2 The goals of this research

In this research the objective is to test the hypothesis that the market for common stock contaminates the market for real estate in times of economic crisis. The main research question that I want to answer is:

"Is financial contagion occurring between the common stock market and the market for real estate in times of financial distress and if yes, to what degree?"

By structuring my research into a set of different steps I hope to be able to answer this question not only as well as possible, but also as detailed as possible. The main research question is split up in a set of sub research questions which allow me to identify the different factors/variables that I need to analyze and include in this research. Also, the sub research questions will be helpful in the operationalization process of the research, meaning that every sub research question will be the equivalent of a certain statistical test that needs to be performed to overall be able to answer the question whether or not financial contagion between the common stock market and the market for real estate occurs.

Although the main goal of the research is to be able to answer the question whether or not financial contagion between the common stock market and the market for real estate occurs with a simple yes or no, it would be even better if the research could also provide insight into the underlying mechanisms that cause financial contagion and their relevant weight. During the research, I will find out to what extent it is possible to analyze the underlying mechanisms of financial contagion and which different factors are driving the occurrence of financial contagion.

1.3 The practical relevance of this research

Literature until this day has paid little attention to investigate relations of financial contagion between the market for common stock and the market for real estate, although there is much literature that studies financial contagion in a cross regional or cross-asset context. When it comes to cross-asset financial contagion though, almost all literature concerns research of financial contagion amongst common stocks. The relevance of this research is therefore to explore to what extent financial contagion occurs between the market for common stock and the market for real estate and to what factors this can be contributed.

The results I hope, will in turn lead to new diversifying insights that can be useful for investment making decisions. If financial contagion between common stock and the market for real estate can be found, this means that in turmoil times the correlation between the market for common stock and the market for real estate is higher than in tranquil periods. This in turn should warn stakeholders investing in real estate on the risks of adding real estate in an investment portfolio because of its risk mitigating reasons. When in times of crises the correlation between common stock and real estate is higher than in stable periods, this means adding real estate to an investment portfolio is not as risk reducing as is often thought.

Since real estate is known as a safe haven investment class, it is much used by investment managers to enhance the risk/return trade-offs of their investment portfolio. Often, adding real estate to an investment portfolio helps this portfolio to become Markowitz optimal, meaning that for a given level of expected return, there is no possibility of rearranging the portfolio so that the portfolio bears a lower amount of risk. Academic literature seems to confirm this view. An academic research of Radnev (1995) shows that adding real estate to a portfolio significantly reduces its risk characteristics and that this reduction can add up to as much as 15%, as was found during an extensive study of many investment portfolios from the period 1980 to 1988.

Fore mostly, this notion is based on real estate having a low correlation with other assets like stocks and bonds.

In the beginning stage of this research it is interesting to imagine why real estate might be susceptible to financial contagion. To have a general understanding of investor behavior, let`s have a look into some theorems that describe it. There are various economic theorems that describe investor behavior.

The flight-to-liquidity theorem predicts that investors in turmoil times prefer assets that are very liquid in the sense that they can be sold in the market in a relatively short notice. This theorem predicts that investors in turmoil periods will sell illiquid assets in favor of liquid assets to maintain their liquidity position parallel to their liquidity preference.

A second theory describing investor behavior is the portfolio rebalancing theorem. This theorem predicts that whenever the relative weight of a specific investment asset class in a portfolio changes, for instance because one class of assets increases or decreases in value, investors will change the various weights of the assets in this portfolio by going short or long because they don’t want a changed diversification.

However, contradictory towards the return maximizing goals of investors seems to be the fact that they sell good performing assets and buy less performing assets just to maintain the diversification profile of their portfolio. Opposed to this theorem is the return chasing theorem that states that investors chase the highest return in investing and therefore do not sell good performing assets just for the benefits of a rebalanced portfolio.

Besides these two theorems that arise from traditional economic thinking the rise of behavioral finance has given another reason to suspect that real estate is susceptible to financial contagion. Where in most cases traditional economic thinking sees herd behavior as irrational behavior, behavioral finance because of its bounded rationality paradigm is capable to explain seemingly irrational herd behavior as rational behavior individually spoken in some cases.

Behavioral finance explains/sees financial contagion as the collective rational way of trading of investors when they individually do not have the information necessary to make a rational decision and therefore consider the trading of the herd as the aggregated outcome of the rational decision making process of other investors which might posses more and better information than themselves. In this way, for individual investors herd behavior is rational, since following the herd in this explanation means making use of the decision outcomes of other investors which have been able to make their decision with more and better information. Collectively however, herd behavior is irrational, because the herd acts without the necessary information.

Behavioral finance also suggests that emotional psychological factors can cause herd behavior. Investors of real estate can get contaminated by pessimistic outlooks on the future state of the economy (e.g. Hirschleifer and Hong Toch, 2003). Because these pessimistic views strike the investors in real estate, a downfall of common stock could offset a turmoil period in real estate markets as well.

1.4 The structure of this research

In the following chapter, the theoretical framework of the thesis will be provided. I will discuss relevant earlier economic research and literature in order to present a clear picture on the current paradigm of economic science on the subject in question. This literature will mainly address the several economic hypotheses that have not yet been falsified and that are necessary as building blocks in this research. Such a hypothesis is for instance the Efficient Market Theory of Fama (1971). In the third chapter the several sub research questions are formulated that in steps will lead to the answering of the main research question. In the fourth chapter, the operationalization of the research questions is discussed. In the fifth chapter the gathering and analyses of the data are discussed and in the sixth, the identified statistical tests are performed to test the hypothesis that contagion is occurring.

The results are presented in chapter seven. In that chapter I will present the outcomes of the statistical test carried out and draw conclusions from them that together lead to the answering of the main research question. Depending on the gathered insights and the limitations experienced during the research I will also provide suggestions for further research.

2. Literature review and theoretical structure

2.1 Review of relevant literature

In the status quo of economic literature, real estate is being considered as a safe haven investment class in a portfolio since it has some special characteristics that makes it unique compared to other asset classes. Amongst real estate's unique characteristics, the most important advantages are:

- Real Estate is believed to have a low correlation with other assets.
- Real Estate can act as a natural hedge against inflation.
- Real Estate unlike many other assets will always retain an intrinsic value.

Due to these characteristics, real estate is often added to an investment portfolio (Friedman, 1971).

2.2 Modern Portfolio Theory

In the field of investment management, before 1952 not much research was spent to answer the question how to maximize the expected profit of an investment portfolio with respect to its risk character. In 1952 however, a mathematician named Markowitz developed a theoretical framework that mathematically tries to describe the process of creating a utility maximizing investment portfolio. It is a theory that is now widely spread and renowned amongst practitioners and scholars. The theory is basically a mathematical construction of the concept of diversification. The goal of diversification and therefore also the goal of the Modern Portfolio Theory (MPT) is to ultimately select a portfolio of assets that all together have a better risk/return character than all these assets individually. To achieve this, the theoretical framework of this method derives all quantitative variables of the assets in question and creates all possible investment portfolios given a specific risk/return character. These portfolios together are called the efficient set.

A Markowitz optimal portfolio therefore is a portfolio which is optimal in terms of its risk/return trade off. A certain investment portfolio can only be called Markowitz optimal if there is no possibility of altering its consistency in such fashion that it would lower its risk profile without also losing expected return, or stated else, that without changing its risk profile, would have an higher expected return.

On the efficient border however, there are many Markowitz optimal portfolios, and which one the investor will choose, is really a matter of the risk and return preferences of the investor in question.

Because stocks and bonds have a low correlation with real estate assets, real estate within the MPT framework provides a way to diversify (Markowitz, 1952). However, in the case in which only private real estate is used, retrieving accurate data on risk and return characteristics is difficult since disclosure on this kind of assets is not made.

When Real Estate Investment Trusts (REITS) were introduced, this problem was eventually overcome. REITS are publicly market traded investment vehicles much like other assets and so information on prices but also information on risks are known. With this data, it is possible to complement the MPT framework. This however, was not done by Markowitz himself, but by Friedman (1971). In his study, Friedman found that real estate could add return to a portfolio without adding extra risk.

He also found that adding real estate to an investment portfolio lowers the standard deviation of its returns due to the low correlation of real estate with other stock and bonds. So when adding real estate to an investment portfolio, in terms of the risk and return characteristics, this portfolio dominates the portfolios without the real estate. Several other economists have confirmed this finding in other researches. Hudson-Wilson and Elbaum (1995) found supportive evidence of real estate improving the performance of a portfolio and also found diversification benefits when homogeneous real estate is added to a mixed assets portfolio. According to several theoretical studies, like Kallberg et al. (1996) and Brounen and Eichholtz (2003) the optimal part of a portfolio consisting of real estate is about 9%, or just under 10%. Hoesli and Witkiewicz (2004) have analyzed the benefits of including real estate in both domestic and international multi-asset portfolios in seven countries. Their research shows that real estate should account for 5 – 15% of a multi-asset portfolio and that the adding of real estate improves the return of such a portfolio by 5 – 10%.

When international real estate is included in the same portfolios, the study finds that the optimal part of real estate in a portfolio is somewhere around 15% and this leads to a risk reduction of somewhere around 10 – 20%.

2.3 The efficient market hypothesis

One of the most widely accepted paradigms in the economic sciences has been that of the Efficient Market Hypothesis (EMH), at least before the 1990´s when behavioral finance that contradicts the EMH to some extend began to flourish. The Efficient Market Hypothesis formulates the extent to which available information is used by investors in their decision making process and therefore which available information is included in the price making process of financial markets. The theorem asserts that financial markets are efficient when it comes to the processing of information. The theorem therefore states that market prices of assets always fully reflect all available information, and that therefore there is no one investor which is able to systematically outperform the market. When stating that markets fully reflect all available information, the theorem makes three categories wherein the soundness of this fact is specified more precisely.

The EMH has a weak, a semi-strong and a strong form of efficiency. The weak-form version of the EMH states that past prices do not contain information on future prices so that all prices must follow a random walk. This means that there are no investors who can systematically outperform the market by making use of its inefficiencies. The semi-strong version of the EMH states that information is being processed so rapidly and unbiased that it is not possible to beneficially trade on this information and that both fundamental analysis and technical analysis are not able to earn excess returns. In the strong version of the EMH, all known information, both private and public, is reflected in prices so that for no one it is possible to earn excess returns.

For a long time, the EMH was the most widely accepted theorem in economics and was the dominant theory in explaining the asset pricing process in financial markets. But when data and empirical evidence for systematic deviations began to rise other theories began to fight against the dominancy of the EMH. One of the first anomalies which gave rise to doubt the rule of the EMH was the winner-loser effect (discovered by De Bondt and Thaler, 1985). This theory contradicts EMH since it shows that investors are overly optimistic about historically good performing stocks and overly pessimistic about historically poor performing stocks, hereby implying that historical results have an influence on future performance.

This belief of investors, which is caused by the extrapolation of the results gathered by technical analysis, causes a deviation from fundamental prices. In time however, these

differences are corrected when the losers increase their performance and the winners will perform poorer than other stocks.

Another anomaly that contradicts EMH is the Equity premium puzzle. The authors of the article in which the theory was discussed first, Benartzi and Thaler (1995) argue that investors prefer investing in stocks over investing in bonds because of their loss-aversion and their habit to frequently monitor their wealth. Therefore, stocks have earned more than bonds over large periods of time.

These two anomalies alone have given economists much doubt about the EMH, but the largest factor causing questions about the soundness of the EMH is herd behavior. Herd behavior is behavior in which economic agents do not act solely on available information, but instead follow a collective of other investors called the herd. Herd behavior is often considered as very irrational since it produces prices which do not match the underlying value of the asset and therefore can create a bubble. Also, in the process of creating a bubble investors often are not trading on recent news but are just following a widespread notion that dominates the market.

The phenomena of herd behavior and the Efficient Market Hypothesis are big contra dictionary phenomena since herd behavior proves that investors trade in assets without new information on them. Whereas the EMH does not provide room for irrational behavior, behavioral finance does. This relatively new branch of economic theory tries to close the gap between empirical evidence and the theoretical framework of the economic science by allowing irrational behavior of economic agents to be one of the paradigms in economic model making.

2.4 Real Estate Investment Trusts

A solution to the valuation problems that arise when real estate is being researched is found in the concept of REITS. REITS (Real Estate Investment Trusts) are investment vehicles containing real estate components. REITS are like other investment vehicles traded for on financial markets which enables valuation of the real estate components of which they consist. REITS have become a popular investment class in the last two decades, and has convinced economic policymakers and financial markets of their benefits. Firstly being introduced in Australia in 1971, lots of countries have followed and have introduced the structure of REITS to provide the opportunity to investors to invest in real estate the same way that mutual funds provide the opportunity to invest in common stock. However, because REITS are traded on stock exchanges the same way as common stocks are, it is likely that REITS are susceptible to increases in volatility caused by external market conditions just like other market traded asset classes are. Although much research has been done to the workings and characteristics of REITS, the degree to which they are vulnerable to contagion from other markets hasn’t been researched yet, which makes my research valuable in terms of increased knowledge on the workings and efficiency of REITS as an asset class.

If this research is an attempt to find out whether financial contagion does occur between the common stock market and the market for real estate, the connection between these two markets must be studied both before, during and after periods of financial crises because only by doing so changes in times of crisis will appear and conclusions can be drawn regarding the effect of economic crisis. In a first step however, before being able to identify crisis periods during a certain timeframe, a clear definition of what is being regarded as a financial crisis is necessary as a benchmark.

A possible but rough definition of a financial crises is a rapid decline in the value of equity. Crises occur when due to all possible kinds of factors the economy of the world is in a state of distress. Reasons for this distress can be: deteriorating current accounts, political turbulences, growth slowdowns and bubbles of all kind. However, also events that are outside an economic category can cause financial crises to occur, such as wars, political crises and during the last decade an increasing terroristic threat and terrorist strikes.

2.5 The definition of financial contagion

The question how financial contagion is defined is key to answering the (main) research question. The general notion is that financial contagion is said to occur when the condition of one market starts to have its influence on the condition of another market. But in order to make the research functional and detailed, a more specific definition of what financial contagion comprises is needed. In economic literature there is no such thing as one exact definition of the concept of financial contagion, but studying literature and reviewing choices regarding defining the concept can be a starting point in finding a proper definition that is also applicable to this specific research.

The majority of literature defines financial contagion as a mechanism in which a bad state economy/market, due to all sorts of economic linkages, starts to worsen the performance of good state economies/markets. Studying literature has resulted in the view that financial contagion is usually not defined precisely but rather in a very broad general kind of way. In Forbes and Riggobon, 2002, for example, financial contagion is defined as the occurrence of an event in one market that transcends to another market or country. This can be measured through economic variables as volatility and covariance. However in this research a more specific definition of contagion is necessary to answer the question whether or not financial contagion occurs and more precisely to which degree.

I have chosen to define financial contagion as the rise in volatility in the market for real estate after a crises has occurred in the common stock market.

In this fashion, by making use of statistical tests suited, I will try to find evidence for a significant increase in volatility in the market for real estate after a certain crisis has occurred in the common stock market. Besides this, I will try to find evidence for a significant increase in correlation between the common stock market and the market for real estate after a crisis has occurred.

Valuing real estate however is not as easy as it is for other assets though, what causes difficulty in studying many topics that regard the value of real estate. Next to this, Real Estate is often categorized in both direct and indirect real estate. Direct real estate is sold directly from owner to buyer and indirect real estate entails real estate sold from seller to buyer by means of intermediate markets. For example, REIT Funds, investment vehicles that consist of several real estate components that are being sold indirectly on an open market to buyers. Often both types of real estate are hard to value. Problems in valuating direct real estate arise because of the fact that these types of real estate are not often traded and in most times, the trade is confidential and so information regarding the price making is not available. The main problem regarding indirect real estate is that it is not uniformly valued. Lastly, when an appraisal based method is used for valuing indirect real estate, it suffers from the effects of smoothing and temporal lagging.

In most economic literature I studied however, the way that contagion was defined was not always the same. Most authors found it difficult to create a clear definition of contagion

which in turn made it difficult to compare research already performed. This ambiguity towards the concept is limiting a successful research and therefore needs to be addressed. In this specific paragraph I will try to end this ambiguity and to create a specific definition of the term financial contagion.

Because the term contagion is a concept that is used to address the interaction or contamination between two entities, but does not precisely define in what way this contamination is achieved, it is probably a good idea to start separating different forms of contagion. In economic literature, Forbes (2002) firstly introduced a separation between two forms of contagion, the plain form of contagion and another form known as “shift contagion”. The difference between these two forms is that instead of the plain form, the term “shift contagion” more explicitly points out that a change in cross-market relations is the underlying cause for contagion. This is another point of view towards contagion than the simple “plain vanilla” version, which describes that even if underlying cross-market relationships do not change, a state of the world of one economy that influences the state of the world of another economy entails contagion (Forbes and Riggobon, 2001). For this research, I have chosen to use the term “shift contagion” instead of the "plain vanilla" contagion for two reasons. Firstly, it provides a clear way of thinking about what exactly constitutes contagion. Only cases in which underlying cross-market relations change would entail contagion. Secondly, this way of defining contagion makes clear how to check whether or not contagion actually does occur and in what way.

To be more precise, taking shift contagion as the definition of contagion in this research implies that a change in cross-market relationships has to be shown before contagion is proved to occur and also opens the way for examining which tests are needed to show that these cross-market relationships have changed.

Next to separating “plain vanilla contagion” and shift contagion several subcategories of contagion can be identified that further shed light on which way contagion manifests itself.

These categories are:

Intra industry contagion
This form of contagion means to describe the way a sector within an industry is capable of contaminating other sectors within that industry.

Inter industry contagion
This form of contagion describes the way in which one specific industry is capable of contaminating another industry. Inter industry contagion was examined by Brewer and Jackson in 2002, were they showed that negative information about the performance of commercial banks had a negative impact on the results of life-insurance companies. They also showed that this negative relation worked in the other direction, in a way that negative news about the performance of life-insurance companies had a significant impact on commercial banks. Lang and Stulz (1992) have also examined inter industry contagion in a study where they indicate that following a bankruptcy announcement of a specific firm the value of comparable value-weighted portfolios dropped by 1%.

Inter country contagion
This form of contagion describes to which extent a specific country is capable of contaminating another country, thus leading to financial contagion on an inter country scale and maybe even on a global scale.

3. Structure of the research

In this chapter the theoretical framework for the rest of the research is presented. This theoretical framework consists of several different parts. Firstly, it tries to identify different concepts that are relevant for the study. Secondly, it helps in defining several concepts that are central in this research, like real estate, financial contagion and efficiency of markets. This chapter will provide the research questions and the coherence between them. Subsequently the methodology to answer the research questions will be discussed and a general idea of the data is provided.

3.1 Formulating the main research question

Real estate as an asset class is considered a safe asset class by both investors and scholars for several reasons. But what if correlations increase during a crisis? Like other stocks, real estate in the form of REITS can be affected by contagion effects. Scholars proved that inter-country contagion effects (King and Wadhwani, 1990), intra-industry contagion effects (Lang and Stultz, 1992) and inter-industry contagion (Gosh et al, 1998) occurred during crises. Little research has been done in the field of real estate and particularly inter-industry studies focusing on the common stock markets and real estate are absent. It is unknown to what extent public real estate is affected by contagion effects caused by panic in common stock markets.

This leads to the main research question:

"Is financial contagion occurring between the common stock market and the market for real estate in times of financial distress and if yes, to what degree?"

By answering this question it becomes clear whether public real estate is affected by contagious movements of common stock. The existence of contagion is determined by the shift of correlations between common stock and property stock during a crisis.

3.2 Sub question 1: change in correlation between markets

Contagion theory is relatively new in the field of real estate. High correlations between common stock markets and public real estate markets are not a sign of contagion, only a sign of high historical dependence. Previous research about contagion (e.g. King an Wadwhani, 1990) shows that increased correlation coefficients during a crisis are used as measure for contagion.

This leads to sub question 1:

Sub question 1: To what extent is the correlation coefficient between the market for common stock and the market for real estate changed when a stable period due to an economic event transcends into an unstable period?

3.3 Sub question 2: change in volatility of market returns

The correlations give a first impression whether and to what extent REITS and common stock move together, before and after a common stock value decline. However, research claims that correlation coefficients are conditional on market volatility (e.g. Longin and Solnik, 1995; Boyer et al, 199; Forbes and Riggobon, 2002). Typically, correlations computed separately for ordinary and stressful market conditions differ considerably, a pattern widely termed as "correlation breakdown" (Boyer et al. 1999). Correlation breakdown makes it impossible to hedge a position perfectly. The breakdown effect is caused by increased volatility. Volatility

biases correlations upward and thus undeserved contagion effects could be detected. The second reason to analyze volatility in both markets is because of the fact that volatility transmits from one market to another and empirical research suggests that increased volatility causes more severe contagion effects (King and Wadwhani, 1990) and increased risk. For these two reasons the volatility of both markets needs to be examined.

This leads to sub question 2:

Sub question 2: To what extent is the volatility of returns for both the common stock market and the market for real estate changed when a stable period due to an economic event transcends into an unstable period?

3.4 Sub question 3: volatility of markets influencing co-movement

A positive effect between shocks and co-movement is expected. Larger shocks lead to stronger co-movement. A positive effect is also expected between volatility and correlation as described by Forbes and Riggobon (2002), known as heteroskedasticity. Volatility makes returns and thus co-movements more extreme. The co-movement between common stock and REITS will be controlled for increased volatility. Therefore a correction is made on the increased correlation between common stock and property stock. This gives understanding in the true underlying linkage between common stock and property stock, unaffected by increased volatility: the true correlation change caused by a stock value decline is revealed. Increased correlations after the shocks corrected for heteroskedasticity are evidence for contagion effects. Because the changed volatility of both markets can affect the correlation coefficients, a correction is made. Forbes and Riggobon (2002) show that contagion effects can be proven less often after a correction for increased volatility of returns.

This leads to sub question 3 in the theoretical framework:

Sub question 3: To what extend is the correlation coefficient between the common stock market and the market for real estate changed in times of economic crisis taking into account the effect of a changed volatility of the common stock market?

4. Research methodology

In the past, various studies using different empirical techniques have measured contagion effects. Some of the methods used are transmission of volatility, correlation coefficients, (Generalized) Auto Regressive Conditional Heteroskedasticity (ARCH, GARCH) analysis, Ordinary Least Squares (OLS), co integration, binary probit models and event studies. Unfortunately, some methods have drawbacks. Correlation coefficients have the problem of heteroskedasticity. ARCH and GARCH models indeed show that volatility transmits across markets.

However, they do not explicitly test whether this transmission changes significantly after a specific shock or crisis (Forbes and Riggobon, 2002). Next to this, there is a downside in using GARCH, since endogenous variables and emitted variables can disrupt a GARCH model. Co-integration is suited to analyze cross-market relationships on the long term. However, cross-market relationships could change for several reasons in the long term and hence, co integration may not test for co-integration effects isolated from other effects. Binary-probit models predict the probability of a crisis and whether this is correlated with the occurrence of a speculative attack in other markets at the same time. This research method avoids the debate on how to define contagion and does not explicitly test for its existence (Forbes and Riggobon, 2002).

This thesis tests the relationships that the common stock market and the market for real estate share by making use of a three phase testing procedure. The thesis firstly uses a volatility analysis and correlation analyses with correction for increased volatility. Using the outcomes of these three different statistical testing procedures eventually I hope to have gained the best insight into the matter possible. In the last stage, included is a test on robustness to gain feeling with the soundness of the results and also a control sample is being put to the test. After having done this, I am ready to give an answer to the main and sub research questions.

4.1 Measuring the correlation between markets

The first and most basic method for measuring contagion is the test based on cross-market correlation coefficients. The correlation (Pxy) is computed by dividing the covariance (σxy) by the multiplied standard deviation of both markets ($\sigma x \sigma y$).

Formula 1.

$$Pxy = \frac{\sigma xy}{\sigma x \sigma y}$$

Formula 2.

$$\sigma xy = covxy = \sum_{s} \Pr(s)\,[(Rx - \overline{Rx})(Ry - \overline{Ry})]$$

Covariance (cov) comprises the summed probability of scenarios (s) multiplied by the actual return of asset x, Rx minus the estimated return $\overline{Rx}$ multiplied by the return of asset y, Ry minus the estimated return $\overline{Ry}$

This method is used to measure the correlation of returns of both the common stock (x) and the property stock (y), so that in turn the correlation coefficient can be computed. In this case, the correlations are computed by using the DataStream Equity Investment and the DataStream Real Estate Index, see paragraphs 4.5 and 4.6 with relevance to the data gathering process. Afterwards the research is narrowed down to a national level. If correlation coefficients increase significantly, this would indicate that contagion effects occurred.

4.2 Measuring the volatility of markets

The analysis of volatility has two motivations. Firstly, transmitted volatility from one market to another is an indication of more severe contagion effects (King and Wadwhani, 1990). Secondly, volatility numbers are needed to cure the heteroskedasticity problem that occurs with the correlation analysis. Forbes and Riggobon (1999) show that the perceived correlation between two stochastic variables, x and y, increases when the variance of x increases, even if the actual correlation between x and y does not change. In their article, Forbes and Riggobon show that although the underlying linkage between two stock markets remains constant, changed volatility will affect estimates of market covariances and correlation. In the low volatility scenario, the returns of the Nasdaq are uniformly distributed, random numbers ranging from -1 to 1 percent. In the high volatility scenario, the return of the Nasdaq will be multiplied by 10 and therefore ranges from -10 to 10 percent.

This problem is referred to as a "correlation breakdown". The correlation coefficients are biased upwards after a shock. Boyer et al. (1999) show that increases in the volatility of returns in the common stock market are generally accompanied by increases in the correlation in the studied data even when "true" market relationships have not been changed. Therefore there is a need to differ between two different types of correlations, a conditional correlation and an unconditional correlation. According to Forbes and Riggobon (2002), the differentiation needed can be quantified as:

Formula 3.

$$r\frac{u}{t} = r_t\sqrt{\frac{(1+\delta t)}{1+\delta t\rho\frac{2}{t}}}$$

Where r_t is the conditional (or unadjusted) correlation of the daily returns and $r\frac{u}{t}$ the unconditional (or adjusted) correlation of the returns, $\rho\frac{2}{t}$ is the actual correlation coefficient. (δ_t) is the relative increase in the conditional variance in the crisis market and is computed by:

Formula 4.

$$\delta_t = \frac{\sigma_{xx}^h}{\sigma_{xx}^l} - 1$$

Now the correlation can be adjusted with the following process. At first, the variance of the common stock returns needs to be determined. This is the unconditional variance. Secondly, the conditional variance is determined by dividing the high market volatility by the low market volatility, minus 1. Thirdly, we compute the unconditional correlation

Formula 5.

$$r_t = \sqrt{\frac{r_t^y}{1+\delta[1-(r_t^u)2]}}$$

This is the correlation adjusted for inequality of variances.

Since the Pearson`s r is not normally distributed, the Fisher z transformation is used to convert the not normal r-distribution to a normal z-distribution. The formula for the transformation is:

Formula 6.

$$Z` = 0.5[\ln(1+r) - \ln(1-r)]$$

Wherein ln is the natural logarithm. The z distribution has the following characteristics:

a. it is normally distributed
b. the standard deviation is written as:

Formula 7.

$$\sigma z = \frac{1}{\sqrt{n-3}}$$

The manipulation of the formulas 6 and 7 gives:

Formula 8.

$$Z - \text{statistic} = (Z(\mu t - Z(\mu s))/(\sqrt{(n \downarrow t)} - 3 + n \downarrow (s-3)) \sim n(0,1)$$

In which n quantifies the number of observations, t resembles the distribution of the turmoil period and s resembles the distribution of the stable period.
Consequently, the z-statistics are compared to the critical z-value.

It is important to have a picture of the historic performance of both the market for common stock and the market for real estate. To acquire this, it is important to look at the historical performance of both markets in the time period researched. This means that in the time period 1990 – 2013 I look at the performance of both the common stock market as well as the market for real estate for the four countries involved in this research: Australia, the U.S., the U.K. and the Netherlands.

4.3 Source for data on common stock

Data as the input of this research is one of the most important aspects of the thesis and therefore needs to be properly described in the way it is used and the way it is interpreted. Originally, my intention was to use data from 1980 to the present but this appeared to be impossible for some countries in this research. Instead, data from 1990 is used, as this seems to be the earliest moment in time for which it is possible to collect data for all countries selected for studying. Gathering data until the year 2013, this provided for a timeframe of 24 years. Data for the countries Australia, the US, the UK and the Netherlands are collected. According to the methodology of this thesis, both data on common stock indices and REITS are collected for all the relevant countries. Comparing these data and running tests to test the hypothesis will make clear to what extent financial contagion between the market for common stock and REIT is occurring. All the tests that are conducted will be repeated on a control sample, to check whether the results found still persist.

As the indicator for the performance of common stock I have chosen to use the DataStream Equity Investment indices. The choice for this database was made for several reasons. Firstly, data on stock performance in this database is available on a daily basis and secondly, this database is in its construction comparable with the database that I will be using for the REITS part of this research. This makes the testing of the hypothesis and the drawing of conclusions easier and more reliable. The data that I use for common stock and REITS are both constructed in DataStream and therefore easier to compare than if I would use data from other databases for REITS and common stock.

The data on common stock performance will be used in this research in three ways. Firstly and most important, it is used to test the relation between the market for real estate and the market for common stock. In other words, it will be used to conduct a correlation of returns analysis between REITS and common stock. The correlation will be that between the DataStream Real Estate Index and the DataStream Equity Investment index. When contagion effects between these two markets really exist, I expect to find increased correlation coefficients after a crisis occurs. The second reason to use data for common stocks is that the volatility in the market for common stock needs to be known. When the volatility of the stock market is known it is possible to make a correction for this effect. Thirdly, common stock data will be used in the control sample that is made. This control sample is used to research whether REITS are more susceptible to contagion effects then other stocks are.

When comparing common stock indices with real estate investment trusts, the question which type of common stock indices should be used is an important one. Traditionally, common stock indices are categorized by different factors, either by the sector that they operate in, like technology, fashion or another sector, or they are categorized by their size in terms of revenue and profit.

Because the research is about common stock, it will not use technology indices. When studying literature, I found that most REITS have a behavior that is identical to mid-sized caps. (Wang et al, 1995). For this reason, for every country that is included in this research, a mid-sized index is selected as the index for common stock for that country.

Four countries are studied: the United States (US), the United Kingdom (UK), The Netherlands and Australia.

The US are selected because they are the most developed and also the largest market for REITS in the world. The UK because it is the largest REITS market in Europe and the Netherlands because they are my domestic market. Australia is selected because besides facilitating REITS trade for over more than 30 years, it is an interesting country to study for geographical reasons.

The common stock market index chosen for the US is the Standard & Poor`s Midcap 400, for the UK it is the Financial Times Stock Exchange Mid Cap index, for the Netherlands it is the Amsterdam Mid Cap Index and for Australia I have chosen the Australian Stock Exchange Mid Cap 50 as the source for data on common stock.

4.4 Source for data on real estate (REITS)

In this research I will use the DataStream Real Estate Indices to find the data necessary to test the hypothesis. I will use this database because it has one huge advantage over other databases. Unlike other databases, which almost all provide monthly return data on REITS, DataStream provides daily return data. This makes the conducting of the research a lot easier and interesting in terms of drawing conclusions. I feel confident in this choice, since most scholars in the field of real estate, like Schultz (2000) have also used data from DataStream to research topics in the field of real estate. In many of those researches a high correlation with other indices was found, which again gives me confidence that DataStream is the right choice for this thesis.

5. Analyses of historical market performance

5.1 Overview of common stock and real estate markets

Before being able to apply statistical tests identified as suited for testing the diverse stated hypotheses, general information about the performance of the studied markets is needed to gain insight into the matter and gain knowledge about their general functioning. An interesting begin when gaining this knowledge is to assess how in the past the markets for common stock and the markets for real estate have been behaving and how their performances have been, both individually and relatively to each other. As indicated in the previous chapter, all data is gathered from the DataStream database and so a first step into gaining knowledge into their functioning is to pick appropriate indices from DataStream as representatives for both the common stock market and the market for real estate. In this first stage, I have decided to analyze the historical performance of the common stock market and the market for real estate on a world level. As a first analysis, a view of the world level will be sufficient. Later on, off course all national levels of the countries under questioning will be analyzed.

For world level analysis, the DataStream equity investment index and the REITS world investment index are chosen as the best indicators of the common stock market and the market for real estate. Since both indices stem from the same database source, using them has a lot of advantages. Some of these advantages are:

- They are both listed from 1980 and are thus available from 1990, when my investigation starts.
- They are both available on a daily basis, which makes them highly accurate.
- They both are denominated in US dollar.

From the indices extracted from DataStream, graph 1 has been construed to visualize the performance of both markets during time.

Graph 1. Historical performance of the common stock market and the market for real estate on world level

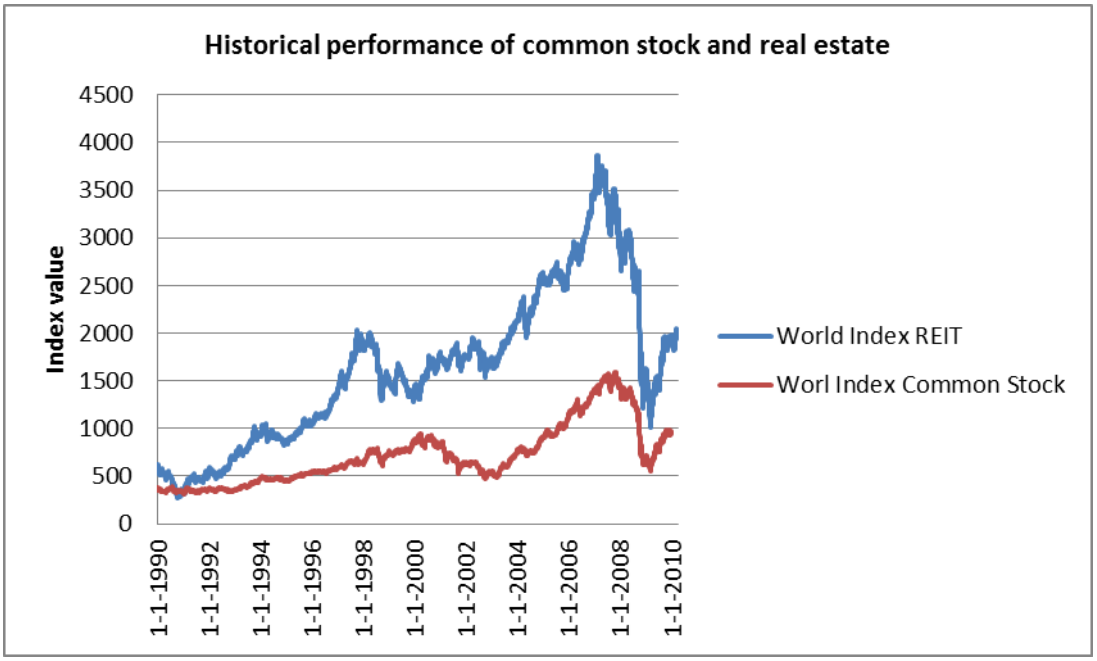

Table 1. daily statistics world level indices						
		1990-1995	**1996-2001**	**2002-2007**	**2008-2012**	**Total period**
Common stock returns	Mean	0.65913	0.30743	0.05574	-0.0101	0.0231
	Volatility	0.723419	0.782119	0.752667	1.309258	0.9039
REIT returns	Mean	0.582481	0.330492	0.038209	0.003926	0.0321
	Volatility	1.4232	0.9268	0.8538	1.7421	1.2655

Table 2. monthly statistics world level indices						
		1990-1995	**1996-2001**	**2002-2007**	**2008-2012**	**Total period**
Common stock returns	Mean	-0.28455	3.556253	2.238839	0.136992	1.469218
	Volatility	0.037287	0.047129	0.040115	0.146296	0.077745
REIT returns	Mean	-0.29699	3.660849	-4.59493	5.820876	0.956818
	Volatility	0.069283	0.053143	0.03982	0.085337	0.062786

The global real estate index outperforms the global common stock index until the year 1997. The global common stock indices overtake the global property in 1998. The higher return expectations in the common stock market pulled money away from the property market. Clayton and MacKinnon (2000) claim that it has been generally argued that REITS, as a whole, are undervalued in this period and trade below their NAV. When the stock market boomed, property shares were out of fashion, and disappeared off the radar screen of most institutional and private investors, despite very attractive income yields. When the stock market collapsed, investors seeking shelter found a safe haven in property shares (Brounen and Eichholtz, 2003, p.3). Real estate values especially boomed in the 2003-2007 period as a result from capital flows directed to private and public property. According to Brounen and Eichholtz (2003) these capital flows are caused by an international change of investor preferences. Sector-rotation can be explained by positive feedback trading strategies and intentional herding as described by Grinblatt et al. (1995) and Froot et al. (2001). The sector-rotation theory is supported by a sample from this research showing that the monthly correlation of property and common stock in the time period was relatively low.

Some simultaneous shocks seem to be visible in the property market and the stock market. The simultaneous shocks contradict theories like ‘sector rotation’, ‘real estate as a portfolio diversifier’ and ‘real estate as a safe haven’. Again, the trend of a rising correlation after 2001 noted by Brounen and Eichholtz (2003) continues in this sample.

5.2 Identifying crisis periods

5.2.1 Identifying crisis periods in the United States

Before analyzing the different performances of the several countries under questioning a procedure for identifying crisis moments must be constructed. After studying literature, and weighing the different pros and cons of all the available procedures, I have come to decide the following procedure.

In a first instance the mean is determined, then in a second step the values for the mean minus two and three times the standard deviation are determined.

In a third and final stage the months that experienced a return that is under the value of the mean minus three times the standard deviation are determined as crisis periods.

Graph 2 Monthly returns of the United States common stock market, used to identify crisis periods through time

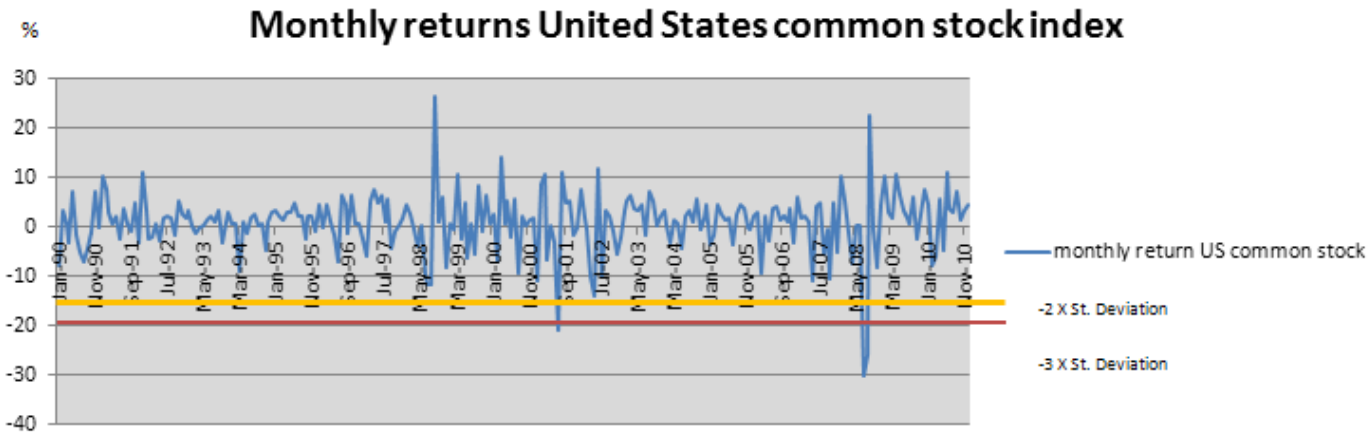

Table 3. Monthly statistics on common stock indices from the U.S.			
mean μ	standard deviation σ	criterion μ-2* σ	criterion μ-3* σ
-1.69295	5.959889	-13.6127	-19.5726

As the graphical analysis of the common stock returns for the US shows us, the returns of the US common stock market have been relatively stable throughout some periods and very volatile and extreme during some other periods. The more volatile periods are seemingly located at the end and beginning of the two decennia that are included in this research. Two crisis are found for the US, the WTC Attack in the year 2001 and the crisis that was originated by the Lehman Brothers failure in the year 2008.

5.2.2 Identifying crisis periods in Australia

Graph 3. Monthly returns of the Australian common stock market, used to identify crisis periods through time

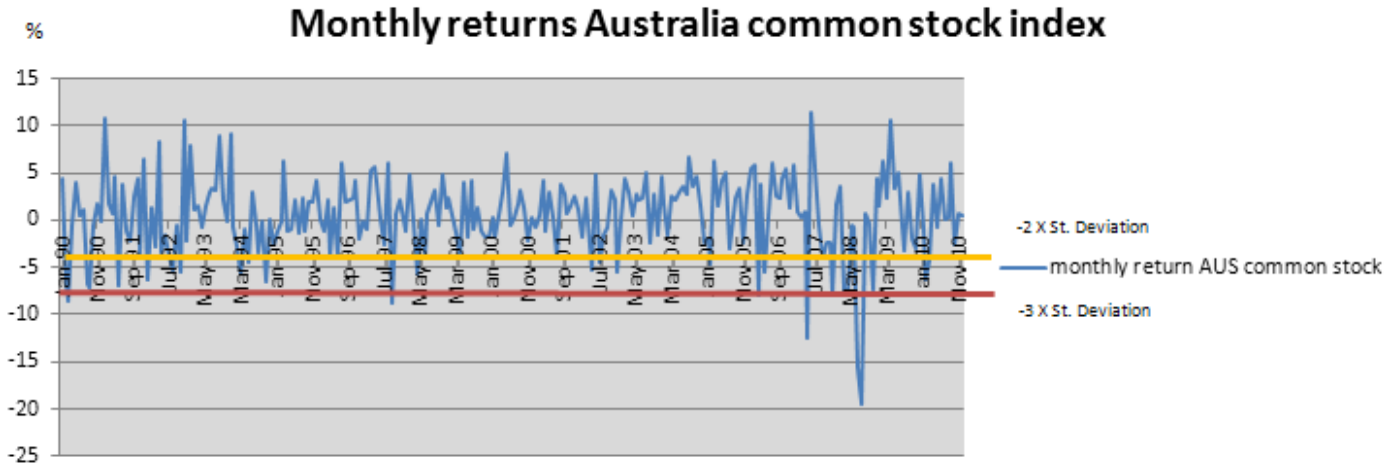

Table 4. Monthly statistics on common stock indices from Australia			
mean μ	standard deviation σ	criterion μ-2* σ	criterion μ-3* σ
0.507933	2.717011	-4.92609	-7.6431

As the graph shows, eventually 5 crises have been found for Australia, the Early 1990`s crisis in 1990, the Asia crisis in 1997, the Credit crunch caused by BNP in 2007, the Lehman Brothers failure in the year 2008 and the Collapse of Bear Sterns in 2008.

5.2.3 Identifying crisis periods in the United Kingdom

Graph 4. Monthly returns of the United Kingdom common stock market, used to identify crisis periods through time

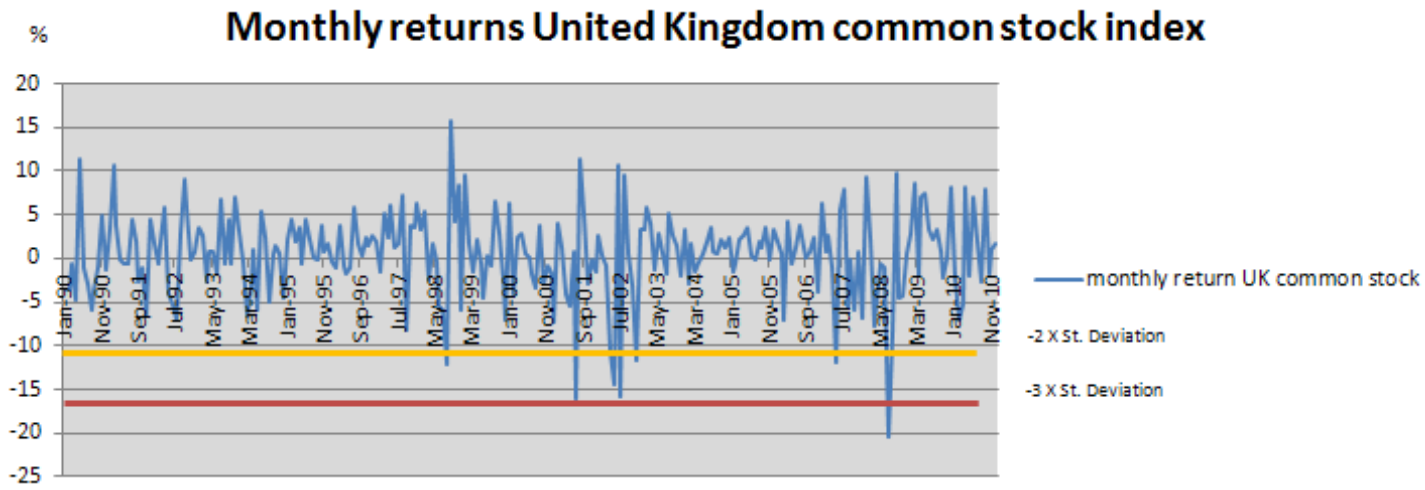

Table 5. Monthly statistics on common stock indices from the U.K.			
mean μ	standard deviation σ	criterion μ-2* σ	criterion μ-3* σ
-2.3598	4.918853	-12.1975	-17.1164

The graph visualizing monthly returns for the common stock market of the United Kingdom shows us that once again, most volatility is showed at the beginning and end of the decennia. Especially in the period 1998 to 2002 volatility seems to be high. In this period the WTC attack has taken place and is defined as a crisis moment for the UK. Also, the fall of Lehman Brothers during 2008 is defined as a crisis period.

5.2.4 Identifying crisis periods in the Netherlands

Graph 5. Monthly returns of the Dutch common stock market, used to identify crisis periods through time

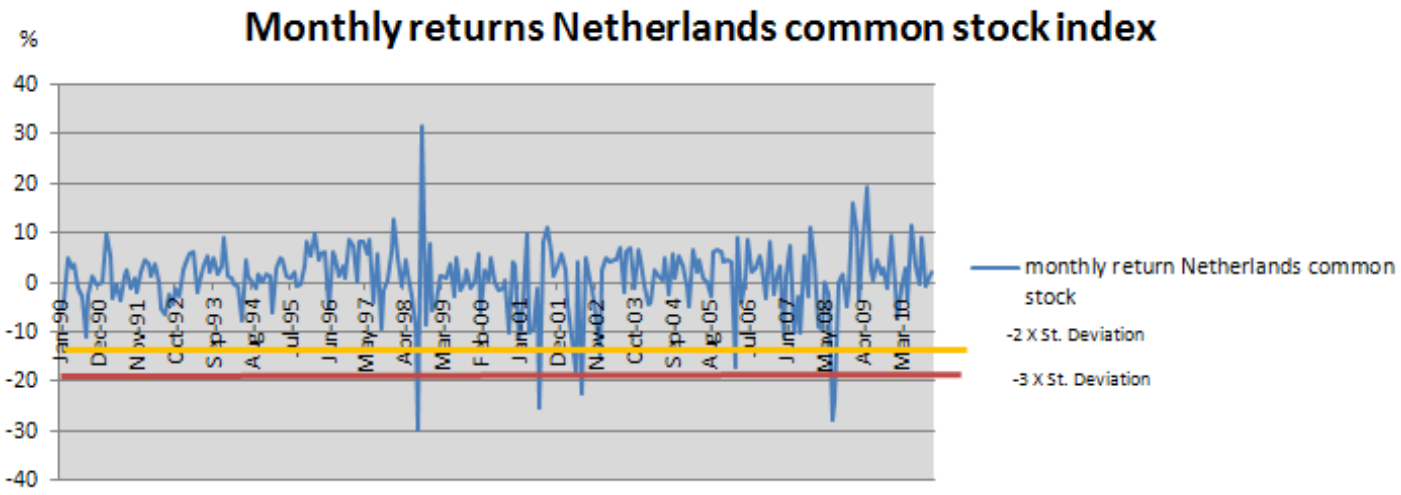

Table 6. Monthly statistics on common stock indices from the Netherlands			
mean μ	standard deviation σ	criterion μ-2* σ	criterion μ-3* σ
0.794349	6.85775	-12.9212	-19.7789

The graph visualizing monthly returns for the common stock market of the Netherlands shows us that the Dutch common stock market is characterized by a very small volatility almost throughout the entire sampling period. There are four points in time, however, that experience a very high volatility, and are thus also defined as crisis moments for studying purposes. These moments are the Russian crisis in 1998, the WTC attack in 2001, the Enron crisis in 2002 and the fall of Lehman Brothers in 2008.

5.2.5 Overview of all found and identified financial crises

Table 7. Overview of financial crisis found in analysis

Nr.	Crisis	United States	Australia	United Kingdom	The Netherlands
1	Early 1990`s crisis (1990)		03-04-1990 to 30-05-1990		
2	Asia crisis (1997)		04-11-1997 to 30-12-1997		
3	Russian crisis (1998)				08-10-1998 to 30-11-1998
4	WTC Attack (2001)	09-11-2001 to 30-12-2001		09-11-2001 to 30-12-2001	09-11-2001 to 30-12-2001
5	Enron crisis (2002)				25-09-2002 to 30-10-2002
6	Credit crunch caused by BNP (2007)		16-08-2007 to 30-09-2007		
7	Lehman Brothers Failure (2008)	21-10-2008 to 30-11-2008	19-03-2008 to 30-04-2008	21-10-2008 to 30-11-2008	21-10-2008 to 30-11-2008
8	Collapse of Bear Sterns (2008)		19-03-2008 to 30-04-2008		

In the table above are listed all found crisis moment suitable for studying purposes.
The only two crises that are found to have influence in more than two countries are the WTC attack and the fall of Lehman Brothers. The WTC attack is found to have influence in both the US, the UK and the Netherlands. The fall of Lehman Brothers has an influence in all countries under investigation. The total number of crisis moments that I have identified amounts up to 13. I find it unexpected that the most moments of crisis are found in the Netherlands and Australia although they have the lowest GDP of the countries under investigation. The reason for this could be that because of their size and because of their dependencies toward other countries they are more vulnerable to external shocks and react more heavily when such a shock does occur.

6. Data

6.1 Correlations

In this section of the research I will make a beginning with calculating all the relevant correlation numbers for the countries under questioning.

6.1.1 Constructing rolling window correlations

Using the data gathered by DataStream, a rolling correlation window for the World level is being constructed. The rolling window correlation is designed in such a way that the last 500 daily correlation numbers are included in the data on a certain point in time. Because this construction is used, the calculated correlation is lagged. However, because values that belong to a later point in time weigh heavier than values belonging to a earlier point in time, a rise in correlation coefficient will transcend to the rolling window correlation quite rapidly and therefore crisis moments causing a rise in correlation between the common stock market and the market for real estate will cause the rolling window correlation to react immediately.

6.1.2 Correlations calculated for the United States

Graph 6. Rolling window correlations for the United States

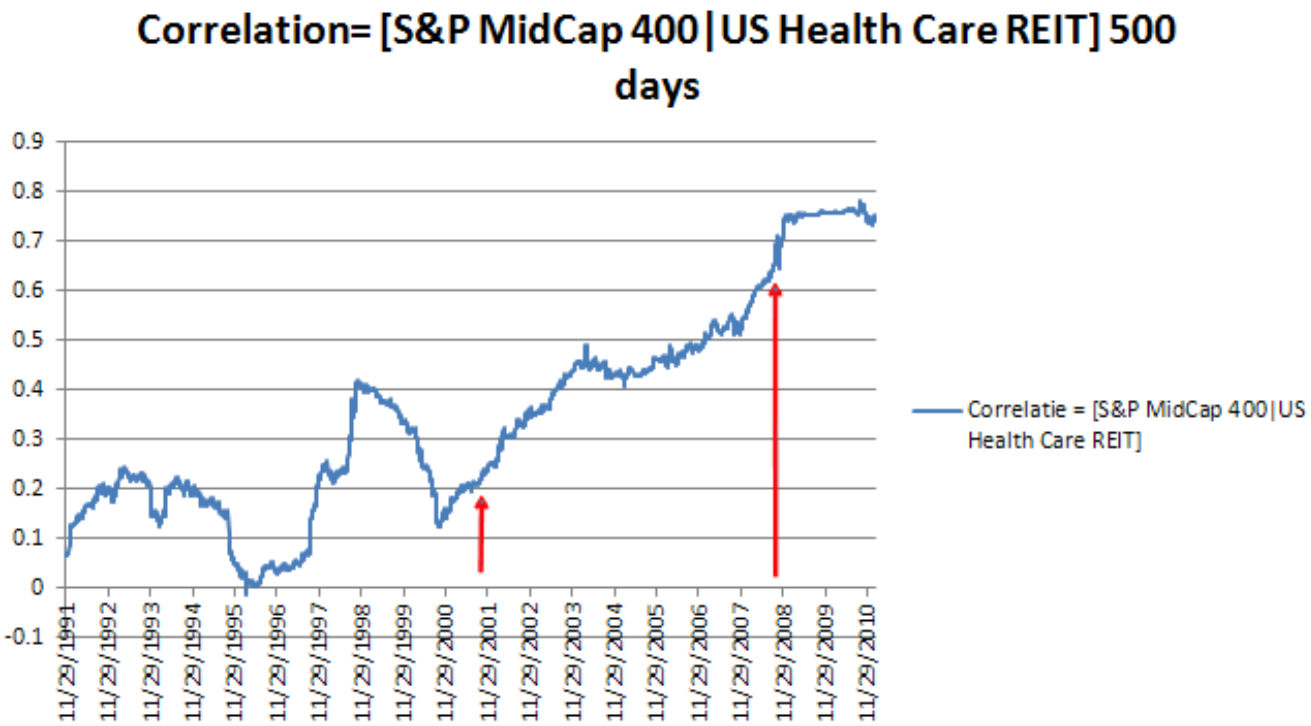

Table 8. time spans of stable and turmoil periods in the United States				
Nr.	Crisis	Stable period	Crisis period	Total time period
4	WTC Attack	09-11-1999 to 09-11-2001	09-11-2001 to 30-12-2001	09-11-1999 to 30-12-2001
7	Lehman Brothers Failure	21-10-2006 to 21-10-2008	21-10-2008 to 30-11-2008	21-10-2006 to 30-11-2008

Graph 6, visualizing the rolling window correlations for the US, shows a steep increase during time. A peek in rolling window correlations is visible in the year 1998. After that a sharp increase begins until the year 2001. From 2001 on, rolling window correlations start to rise again, ascending all the way until 2009 when they flatten out.

During the WTC attack (2001), a rise in rolling window correlations is visible although modest. During the Lehman Brothers failure a more steep increase in rolling window correlations is visible.

6.1.3 Correlations calculated for Australia

Graph 7. Rolling window correlations for Australia

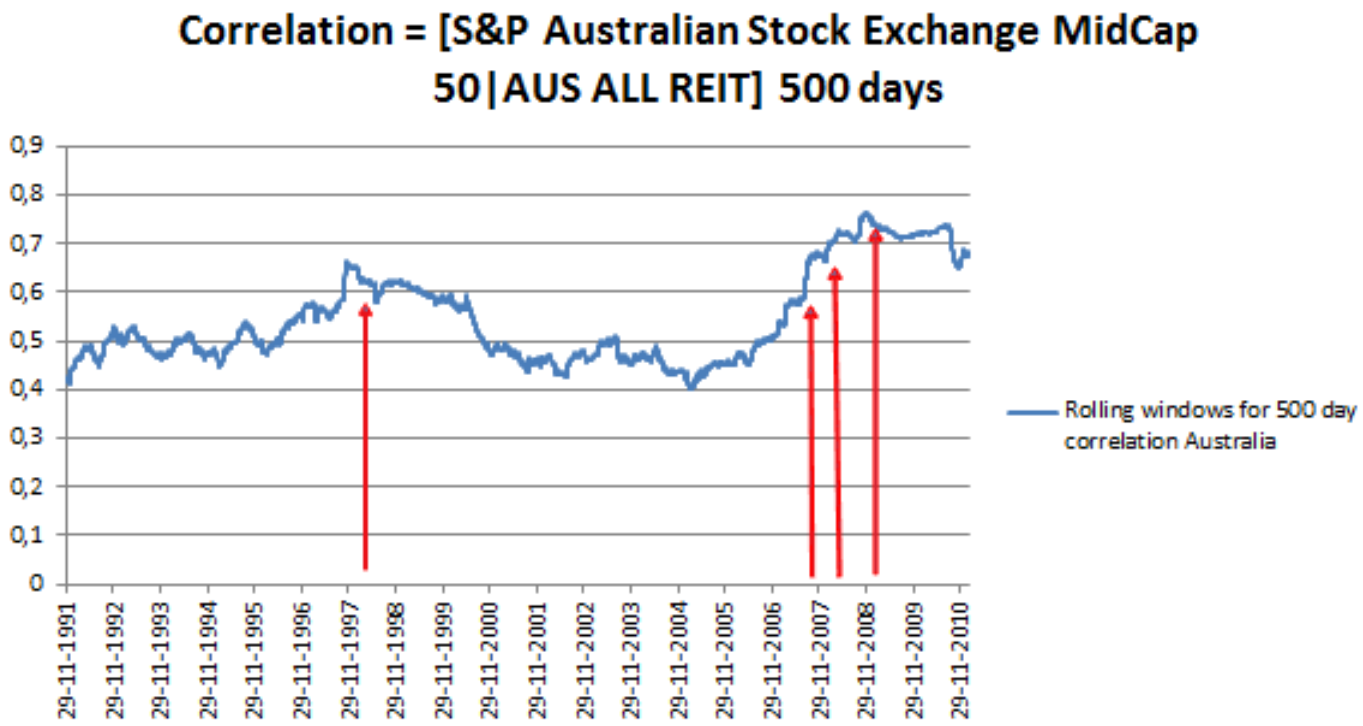

Table 9. time spans of stable and turmoil periods in Australia				
Nr.	Crisis	Stable period	Crisis period	Total time period
1	Early 1990`s crisis *	03-04-1988 to 03-04-1990	03-04-1990 to 30-05-1990	03-04-1988 to 30-05-1990
2	Asia crisis	04-11-1995 to 04-11-1997	04-11-1997 to 30-12-1997	04-11-1995 to 30-12-1997
6	Credit crunch caused by BNP	16-08-2005 to 16-08-2007	16-08-2007 to 30-09-2007	16-08-2006 to 30-09-2007
7	Lehman Brothers Failure	19-03-2006 to 19-03-2008	19-03-2008 to 30-04-2008	19-03-2006 to 30-04-2008
8	Collapse of Bear Sterns	19-03-2006 to 19-03-2008	19-03-2008 to 30-04-2008	19-03-2006 to 30-04-2008

* = because of the lag (500 days) that I used for the rolling correlating window data on the early 1990`s crisis is not available so that this crisis will remain undiscussed.

Graph 7, visualizing correlations for the Australian market shows a relatively steady rolling window correlation throughout time. Curvature is relatively flat and is only apparent in the years 1997 and 2007-2008. During the crisis periods defined for the Australian market, an increase in rolling window correlations is visible.

A peek in rolling window correlations in visible in the year 1997. After that a decrease begins until the year 2001. From 2005 on, rolling window correlations start to rise again, ascending all the way until 2009 when they flatten out.
During the WTC attack, a rise in rolling window correlations is visible although modest.
During the Lehman Brothers failure (2008) a more steep increase in rolling window correlations is visible.

6.1.4 Correlations calculated for the United Kingdom

Graph 8. Rolling window correlations for the United Kingdom

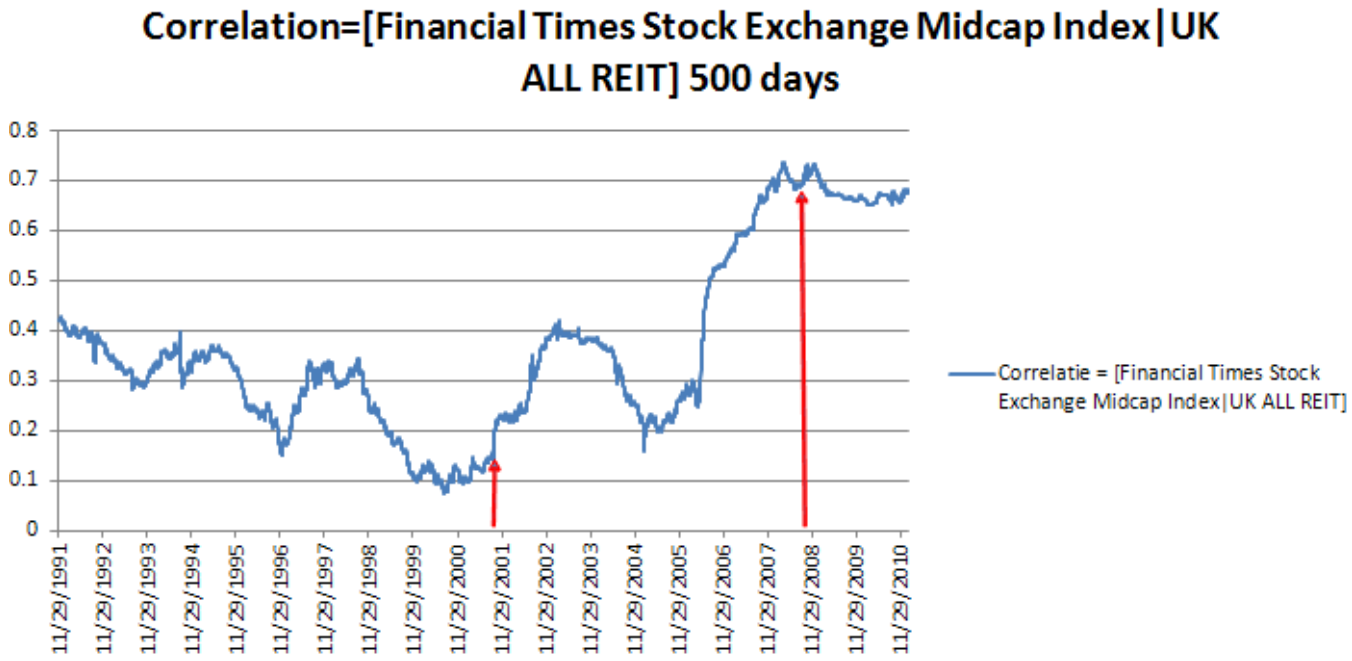

Table 10. time spans of stable and turmoil periods in the United Kingdom				
Nr.	Crisis	Stable period	Crisis period	Total time period
4	WTC Attack	09-11-1999 to 09-11-2001	09-11-2001 to 30-12-2001	09-11-1999 to 30-12-2001
7	Lehman Brothers Failure	21-10-2006 to 21-10-2008	21-10-2008 to 30-10-2008	21-10-2006 to 30-10-2008

Graph 8, visualizing correlations for the United Kingdom shows a relatively curved rolling window correlation throughout time. Curvature is apparent throughout the entire timeframe, especially during the time periods 2001-2004 and 2005-2008. The WTC attack is followed by a steep increase in rolling correlations. Also, after the failure of Lehman Brothers an increase of rolling correlations is visible for the UK.

6.1.5 Correlations calculated for the Netherlands

Graph 9. Rolling window correlations for the Netherlands

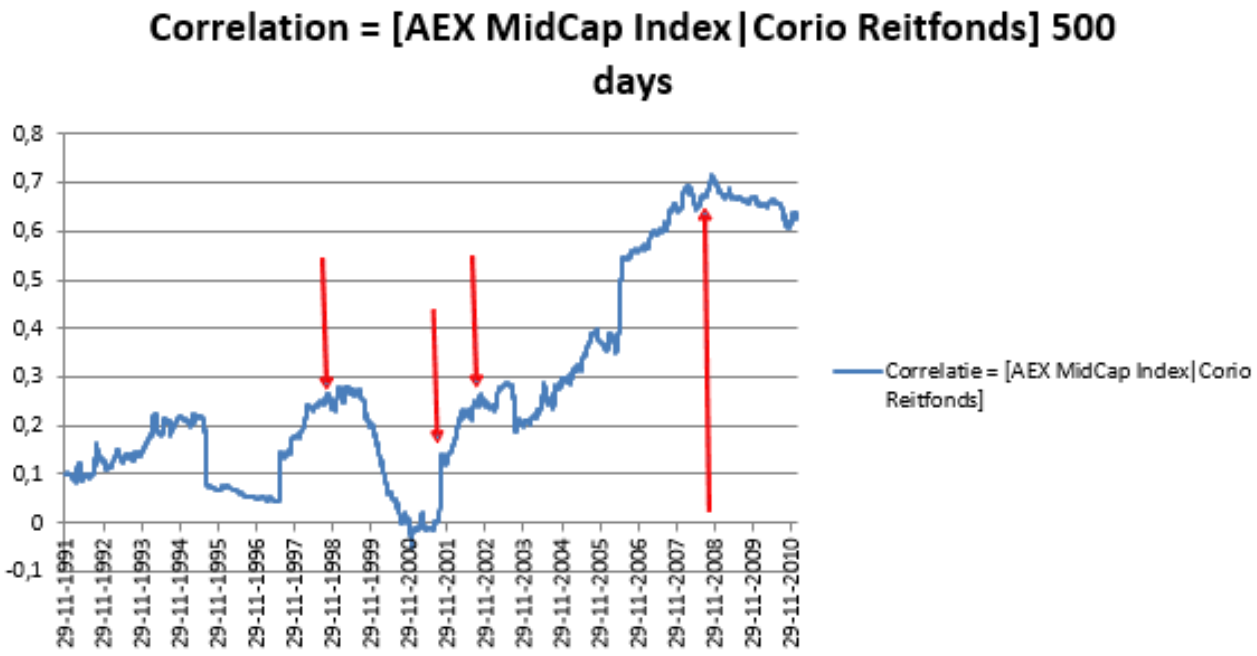

Table 11. time spans of stable and turmoil periods in the Netherlands				
Nr.	Crisis	Stable period	Crisis period	Total time period
3	Russian crisis	08-10-1996 to 08-10-1998	08-10-1998 to 30-11-1998	08-10-1997 to 30-11-1998
4	WTC Attack	09-11-1999 to 09-11-2001	09-11-2001 to 30-12-2001	09-11-2000 to 30-12-2001
5	Enron crisis	25-09-2000 to 25-09-2002	25-09-2002 to 30-10-2002	25-09-2001 to 30-10-2002
7	Lehman Brothers Failure	21-10-2006 to 21-10-2008	21-10-2008 to 30-11-2008	21-10-2007 to 30-11-2008

Graph 9, visualizing correlations for the Dutch market shows that the rolling window correlation is characterized as very volatile. In the beginning of the timeframe researched it is very small, during 1997-1999 there is a peak in rolling window correlations. In 2001, during the WTC attack rolling window correlations rise again very quickly, and keep rising until 2008. Out of all countries under study, the rolling window correlations of the Netherlands are the most volatile.

6.2 Testing changed correlation

In the previous section (6.1) the crises are indicated in correlation graphs for rolling windows. In this section Pearson correlations of stable periods are compared with the Pearson correlations in turmoil periods as indicated in tables 12, 13 and 14.

The equality of correlations is tested. Z - test is used to evaluate if there is a significant increase in correlation during the turmoil period, compared to the stable period. Rs is the correlation in the stable period and Rt the correlation in the turmoil period. Hypothesis one states that the correlation in the stable period is smaller than the correlation in the turmoil period.

$$H0: Rs = Rt$$

$$H1: Rs < Rt$$

The conditional correlations for the stable and turmoil periods are shown in table 12. Correlations for the stable and turmoil periods are indicated with R. The increase in correlation of the crisis period relative to the stable period is indicated. The critical z-value is indicated and it is shown if the correlation in the turmoil period is statistically different from the stable period at a 10%, 5% or 1% significance level for a one-tail test. When contagion is found, this is indicated by the Y of yes, if contagion is not found, this is indicated by the N of no.

Table 12. Conditional Correlation coefficients									
			Stable period		Unstable period		Increase R	z-statistic	Contagion proven
	Nr.	Crisis	Correlation R	Volatility S (%)	Correlation R	Volatility S (%)			
United States	4	WTC Attack	0.23148	0.015362	0.22833	0.017496	-0.00315	-0.01439	Y
	7	Lehman Brothers Failure	0.566893	0.019554	0.74669	0.0475	0.179797	1.395591	N
United Kingdom	4	WTC Attack	0.185623	0.011706	0.213549	0.017655	0.027926	0.431784	N
	7	Lehman Brothers Failure	0.65375	0.019947	0.72702	0.036221	0.07327	0.608324	N
Australia	1	Early 1990`s crisis	0.116576	0.010578	0.34554	0.008787	0.228964	0.423384	N
	2	Asia crisis	0.53833	0.014352	0.65519	0.017017	0.11686	0.789917	N
	6	Credit crunch caused by BNP	0.504145	0.009237	0.662625	0.014398	0.15848	1.049966	Y
	7	Lehman Brothers Failure	0.65044	0.0177	0.75583	0.0258	0.10539	0.910296	N
	8	Collapse of Bear Stearns	0.56952	0.008115	0.717223	0.01025	0.147723	1.104012	N
The Netherlands	3	Russian crisis	0.14575	0.014271	0.24886	0.018229	0.10311	0.464773	N
	4	WTC Attack	0.05471	0.012869	0.04959	0.018481	-0.00512	-0.02222	N
	5	Enron crisis	0.09487	0.014088	0.25357	0.018841	0.15875	0.464345	N
	7	Lehman Brothers Failure	0.63565	0.020719	0.69494	0.037185	0.05929	0.461333	Y

As is shown in table 12, the correlations matching most stable periods are lower than correlations during unstable periods. The average correlation during stable times amounts 0.397. The average correlation during unstable periods amounts to 0.497. Thus, on average the correlations of unstable periods are 0.10 higher than in stable periods.

In one case, during the crisis caused by the WTC attack in September the 11th, which caused great panic and confusion amongst investors due to an uncertain future, a decrease in correlation for the US relevant markets is visible. This is contrary to the belief that during times of crisis markets are more connected, and thus leaves the question why exactly after the terrorist attacks of September the 11th, the common stock market and the market for real estate in the US are less intertwined than during the stable period.

6.3 Testing changed volatility

Since variability is a measure for risk and can affect the correlation between common stock and property stock, it is needed to test whether the stable and turmoil period have a significant different variance. Levene`s test (Levene et al, 2006) is used to test the statistical equality of variances for two independent samples under the assumption that the two populations are normally distributed. This is a two tailed test. The null hypothesis states that the variances are equal.

$$H0: \partial s = \partial r$$

$$H1: \partial s < \partial t$$

Table 13. Levene`s test for equality of variances								
			Common stock			Property stock		
	Nr.	Crisis	Stable S(%)	Turmoil S(%)	F-statistic	Stable S(%)	Turmoil S(%)	F- statistic
United States	4	WTC Attack	0.015362	0.017496	-0.01439	0.02443	0.057103	-0.01439
	7	Lehman Brothers Failure	0.0177	0.0258	1.049966	0.03449	0.059554	1.104012
United Kingdom	4	WTC Attack	0.010578	0.008787	0.910296	0.01001	0.009602	0.464773
	7	Lehman Brothers Failure	0.089152	0.045641	1.143232	0.08452	0.056412	-0.05651
Australia	1	Early 1990`s crisis	0.014352	0.01025	0.464773	0.01001	0.059554	0.464773
	2	Asia crisis	0.014271	0.017017	-0.02222	0.00711	0.01052	0.461333
	6	Credit crunch caused by BNP	0.323369	0.432222	-0.03432	0.04534	0.02454	1.067821
	7	Lehman Brothers Failure	0.014088	0.018481	0.432423	0.13222	0.05652	0.910296
	8	Collapse of Bear Stearns	0.009237	0.014398	1.104012	0.01256	0.020272	1.104012
The Netherlands	3	Russian crisis	0.014352	0.01025	0.464773	0.010015	0.014608	0.464773
	4	WTC Attack	0.014271	0.017017	-0.02222	0.007117	0.01052	-0.02222
	5	Enron crisis	0.012869	0.018229	-0.02254	0.026643	0.042673	0.464773
	7	Lehman Brothers Failure	0.058623	0.025632	0.461333	0.016142	0.014608	0.461333

In all common stock cases the variance increased significantly after a crisis: the variance in the turmoil period is significantly larger than the variance in the stable period. This means that the risk in the common stock market increased. All cases are significant at a 1% confidence level (p=0.01) except the fourth crisis in the UK. This increase of variances is significant at a 5% confidence level (p=0.05). For all property stock cases, the variance (risk) increases. All cases of increased variances are significant at a confidence level of 1% (p=0.01) except one. After the second crisis in the UK, the variances increase but not significant. The adjustment by using formulas 4 and 5 lowers the correlation in the turmoil periods. It has a large impact on the significance of the results. In three cases, the correlation is lower in the turmoil period than in the stable period. In five cases the correlation is still higher in the turmoil period but not statistically deviating from the stable period. The correlations in crisis periods are larger than the correlations in stable periods in four out of twelve cases, hence contagion effects

are found. September the 11th (WTC Attack) caused a contagion effect in the UK with a significance level of 10% (p=0.1). After the collapse of Lehman Brothers a contagion effect occurred in the UK at a significance level of 1% (p=0.01).

6.4 Testing changed correlations adjusted for changed volatility

The proposed correction of Forbes and Riggobon (2002) is used to adjust the correlations for the increased volatility in the common stock market. The results are presented in table 14. The adjustment by using formulas 4 and 5 lowers correlation in the turmoil periods. It has a large impact on the significance of the results. In two cases, the correlation is lower in the turmoil period than in the stable period. This means that the risk in the common stock market increased. All cases of increased variances are significant at a confidence level of 1% (p=0.01) except one. After the second crisis in the UK, the variances increase significantly.

Table 14. Unconditional Correlation coefficients									
			Stable period		Unstable period		Increase R	z-statistic	Contagion proven
	Nr.	Crisis	Correlation R	Volatility S (%)	Correlation R	Volatility S (%)			
United States	4	WTC Attack	0.23148	0.015362	0.22833	0.017496	-0.00315	1.395591	Y
	7	Lehman Brothers Failure	0.566893	0.019554	0.74669	0.047554	0.17997	-0.01439	Y
United Kingdom	4	WTC Attack	0.116576	0.011706	0.213549	0.017655	0.39673	1.395591	N
	7	Lehman Brothers Failure	0.65375	0.019947	0.727025	0.036221	0.07327	0.431784	N
Australia	1	Early 1990`s crisis	0.019947	0.010578	0.056232	0.255461	0.03285	0.608251	N
	2	Asia crisis	0.53833	0.014352	0.65519	0.017017	0.11686	1.104012	N
	6	Credit crunch caused by BNP	0.504145	0.009237	0.662625	0.014398	0.15848	0.910296	N
	7	Lehman Brothers Failure	0.65044	0.0177	0.75583	0.025585	0.10539	1.152653	Y
	8	Collapse of Bear Stearns	0.5695	0.008115	0.717223	0.010245	0.14723	1.049966	Y
The Netherlands	3	Russian crisis	0.14575	0.014271	0.24886	0.018229	0.10311	0.789917	N
	4	WTC Attack	0.05471	0.012869	0.04959	0.018481	-0.00512	0.464773	N
	5	Enron crisis	0.09487	0.014088	0.25357	0.018841	0.15587	-0.026562	N
	7	Lehman Brothers Failure	0.63565	0.020719	0.69494	0.037185	0.05929	0.4562356	N

6.5 The control sample

Table 15. Control sample of the conditional Correlation coefficient									
			Stable period		Unstable period		Increase R	z-statistic	Contagion proven
	Nr.	Crisis	Correlation R	Volatility S (%)	Correlation R	Volatility S (%)	Increase in r		
United States	4	WTC Attack	0.23148	0.015362	0.22833	0.017496	-0.00315	-0.01439	Y
	7	Lehman Brothers Failure	0.566893	0.019554	0.74669	0.04754	0.17797	1.395591	N
United Kingdom	4	WTC Attack	0.116576	0.011706	0.213549	0.017655	0.09673	0.431784	N
	7	Lehman Brothers Failure	0.65375	0.019947	0.72702	0.036221	0.07327	0.608251	N
Australia	1	Early 1990`s crisis	0.10345	0.010578	0.23545	0.008787	0.03685	0.653521	N
	2	Asia crisis	0.53833	0.014352	0.65519	0.017017	0.11686	0.789917	N
	6	Credit crunch caused by BNP	0.504145	0.009237	0.662625	0.014398	0.15848	1.049966	Y
	7	Lehman Brothers Failure	0.65044	0.0177	0.75583	0.02584	0.10539	0.910296	N
	8	Collapse of Bear Stearns	0.56954	0.008115	0.717223	0.01025	0.14723	1.104012	N
The Netherlands	3	Russian crisis	0.14575	0.014271	0.24886	0.018229	0.10311	0.464773	N
	4	WTC Attack	0.05471	0.012869	0.04959	0.018481	-0.00512	-0.02222	N
	5	Enron crisis	0.09487	0.014088	0.25357	0.018841	0.15587	0.586234	Y
	7	Lehman Brothers Failure	0.63565	0.020719	0.69494	0.037185	0.05929	0.461333	Y

Table 16. Levene`s test for equality of variances for the control sample								
			Common stock			Property stock		
	Nr.	Crisis	Stable S(%)	Turmoil S(%)	F-statistic	Stable S(%)	Turmoil S(%)	F- statistic
United States	4	WTC Attack	0.019554	0.0475	1.395591	0.015756	0.014488	1.395591
	7	Lehman Brothers Failure	0.015362	0.017496	-0.01439	0.024435	0.057103	-0.01439
United Kingdom	4	WTC Attack	0.011706	0.017655	0.431784	0.007259	0.014876	0.431784
	7	Lehman Brothers Failure	0.019947	0.036221	0.608251	0.026237	0.044074	0.608251
Australia	1	Early 1990`s crisis	0.010578	0.008787	0.910296	0.010015	0.009602	0.910296
	2	Asia crisis	0.014352	0.01025	0.464773	0.025632	0.045263	0.464773
	6	Credit crunch caused by BNP	0.009237	0.014398	1.104012	0.01254	0.020272	1.104012
	7	Lehman Brothers Failure	0.0177	0.0258	1.049966	0.034494	0.059554	1.049966
	8	Collapse of Bear Stearns	0.008115	0.01025	0.789917	0.014324	0.023634	0.789917
The Netherlands	3	Russian crisis	0.014271	0.017017	-0.02222	0.007117	0.01052	-0.02222
	4	WTC Attack	0.012869	0.018229	0.748563	0.026643	0.042673	0.786532
	5	Enron crisis	0.014088	0.018481	0.461333	0.016142	0.014608	0.461333
	7	Lehman Brothers Failure	0.63565	0.037185	0.653214	0.026643	0.042673	1.045236

Table 17. Unconditional Correlation coefficients for the control sample									
			Stable period		Unstable period		Increase R	z-statistic	Contagion proven
	Nr	Crisis	R	S(%)	R	S(%)			
United States	4	WTC Attack	0.23148	0.015362	0.22833	0.017496	-0.00315	-0.01439	N
	7	Lehman Brothers Failure	0.566893	0.019554	0.74669	0.04755	0.17797	-0.04526	Y
United Kingdom	4	WTC Attack	0.116576	0.011706	0.213549	0.017655	0.09673	1.395591	N
	7	Lehman Brothers Failure	0.65375	0.019947	0.72702	0.036221	0.07327	0.431784	N
Australia	1	Early 1990`s crisis	0.036221	0.010578	0.25263	0.008787	0.03685	0.608251	N
	2	Asia crisis	0.53833	0.014352	0.65519	0.017017	0.11686	1.104012	N
	6	Credit crunch caused by BNP	0.504145	0.009237	0.662625	0.014398	0.15848	0.910296	N
	7	Lehman Brothers Failure	0.65044	0.01775	0.75583	0.02586	0.10539	0.752632	Y
	8	Collapse of Bear Stearns	0.5695	0.008115	0.717223	0.01025	0.14723	1.049966	Y
The Netherlands	3	Russian crisis	0.14575	0.014271	0.24886	0.018229	0.10311	0.789917	N
	4	WTC Attack	0.05471	0.012869	0.04959	0.018481	-0.00512	0.464773	N
	5	Enron crisis	0.09487	0.014088	0.25357	0.018841	0.15887	-0.02222	N
	7	Lehman Brothers Failure	0.63565	0.020719	0.69494	0.052632	0.05929	0.15243	N

Comparison between the normal investigation and the control sample shows that shortening the timeframe under which the rolling window correlation is being calculated affects the outcomes. There is now one case less in which contagion effects from the common stock market to the market for real estate are being found.

6.6 Bootstrap testing procedure

Whilst executing the previous statistical tests the outcomes in some instances have appeared to be relatively questionable with respect to the showing of contagion in some timeframes. Doubts towards the findings of the research had begun to rise after comparing these results with the results of other studies that have tried to show contagion.

In an attempt to clarify this matter, another test has been used to show contagion. This test is the Hatemi -J and Hacker test. The test is a bootstrap test used to evaluate the change in correlation in a specific timeframe.

The empirical results are presented in the tables below. Based on these results I can conclude that the relationship between the common stock market and the real estate market for the countries studied cannot be characterized by contagion but rather dependency that prevails regardless of which state (normal or distress) that the markets are in. This is based on the fact that the negative change in the slope is not statistically significant in any case. It should be mentioned that the intercept, which can be considered as a measure of risk premium for investing in the US real estate market, is not statistically significant in any of the cases investigated. This seems to be true in both the stable periods as well as in the crisis periods.

Table 18. Outcomes of the Hatemi - J. and Hacker Test

	Intercept	Change in Intercept	Slope	Change in slope
US	0.0534	-0.3528	0.302	-0.034
UK	0.134	-0.103	0.563	-0.203
Australia	0.024	-0.100	0.452	-0.032
The Netherlands	0.542	-0.003	0.354	-0.004

Table 19. Outcomes of the Hatemi - .J and Hacker Test for the control sample

	Intercept	Change in Intercept	Slope	Change in slope
US	0.0435	-0.338	0.286	-0.013
UK	0.145	-0.106	0.545	-0.041
Australia	0.345	-0.087	0.432	-0.002
The Netherlands	0.432	-0.001	0.324	-0.003

6.7 Robustness of the tests performed

A sensitivity test is executed to analyze the robustness of the results, presented in the appendix. In this test the stable estimation period is changed to 30 trading days instead of 500 trading days. The correlation in 30 trading days, 14 days prior to the crisis is investigated. Conditional correlations increased in eleven out of twelve cases. The average stable period correlation is 0.450. The average increase during a crisis is 0.251. The increase is in five out of twelve cases significant, hence, contagion effects are found for five cases. A contagion effect is also found in the UK after September the 11th. Volatility increases in eleven out of twelve cases. When controlled for increased variances by using formulas 4 and 5, increased unconditional correlations show that an increase is occurring less often, in accordance to literature studied (see table 17).

7. Conclusions, answering the research question

7.1 Answering sub question 1

What is the effect of a crisis on the common stock market on the correlation between the returns of the common stock market and the returns of public real estate market?

This research focused on the state dependency of correlations between common stock and property stock. This research shows that correlations increase after a shock or crisis on the common stock market. More specifically: correlations between common stock and property stock increase significantly in four cases in this research.

In one case the correlation decreased, however, non-significantly. The change in correlation between stable and turmoil periods ranges from -0.021 to 0.597. On average, the correlations increased with an impressive 0.125 including the case with a decreased correlation. According to the definition of contagion as a significant increased correlation after a crisis, four contagion effects occurred between the common stock market and the property stock market. In the US market, contagion effects in Real Estate Markets only occurred after the Collapse of Lehman Brothers. In the UK market, contagion effects occurred after all crises.
In Australia contagion effects could not be proven. In the Netherlands contagion effects didn't occur at all.

7.2 Answering sub question 2

What is the volatility of returns of both the common stock and the property stock market before and after a crisis in the common stock market?

This research shows that the volatility of common stock market returns increase after a shock although less convincing than originally thought and less often than comparable research indicates.
Volatility on the property stock market increases in five cases of which two are significant. In one case (the Collapse of Lehman Brothers, US) the volatility decreases non-significantly. It is remarkable that in this case, the correlation also does not increase, as described in the previous sub question. In general, it can be said that volatility increases after a crises.

7.3 Answering sub question 3

What is the effect of a significant decrease in common stock value on the co-movement between common stock returns and REITs returns after a correction for a changed volatility?

After a correction for unequal variances as proposed by Forbes and Riggobon (2002), correlations between common stock and property stock increase during a crisis in two cases. Hence, contagion occurred in these cases even when using this strict approach.

Correlations between common stock and property stock increase on average with 0.12 after a shock, including the cases with decreased correlations. Significant increases of correlation after a shock are found in Australia and the UK. Hence, contagion effects are found in the UK and Australia. In the UK, contagion effects between the common stock market and the property stock market are found after the Collapse of Lehman Brothers and September the 11th (WTC Attack) .

7.4 Answering the main research question

To what extent is public real estate affected by financial contagion?

The outcome of the research is not entirely consistent with my expectations. The outcomes indicate that in times of crises, financial contagion does indeed occur which in that sense proves that adding real estate to a portfolio significantly reduces the risk profile of such a portfolio.

However, I have only proved contagion in two instances. At the start of the investigation, I expected contagion to occur frequently. The results can be of input to fund managers, who are interested in finding out how they can add real estate to investment portfolios for risk reducing purposes.

7.5 Suggestions for research possibilities

This study is the first to introduce the finding of increased co- movement of real estate and common stock after a shock on the common stock market. This finding has considerable implications for investors and their real estate allocations. In line with the portfolio rebalancing explanation as discussed above, further research could investigate optimal real estate allocations in a multi-asset portfolio when taking contagion theory into account.

Moreover, it is unclear whether other assets are affected by contagion. Allocations for other assets that are perceived as a safe asset class (e.g. gold, Swiss Franc) could be reconsidered. In line to the flight-to-liquidity explanation, further research could focus on the change of liquidity during contagion effects or the transmission of illiquidity during a crisis.

Kyle (1985) describes the liquidity of a financial asset using three concepts: Tightness, Depth and Resilience. Tightness: does contagion affect the possibility of liquidating real estate in a short time? Depth: does trading in real estate have less depth during periods of financial crisis? With other words, is it more difficult to trade large quantities of public real estate during contagious movements of the common stock market? Resilience: is real estate able to recover from a random shock in the market when taking contagion theory into account?

The impact of the herding may increase contagion effects in the future. As contagion theory becomes more accepted by real estate investors, they might anticipate on a crisis by selling real estate in advance. This would cause more severe contagion effects. Further research could focus on the behavioral aspects. This research shows that investors should not invest in real estate because of the low correlations with other stocks. Real estate investors should allocate in line with optimal portfolio theory that takes contagion effects of the common stock market into account. New optimal allocations will probably be lower than optimal allocations without taking contagion effects into account. However, this research does not suggest that investors should avoid real estate allocations in a portfolio. In line with the findings of Hudson-Wilson et al. (2005) real estate still achieves absolute returns above the risk-free rate, real estate is a hedge for inflation and real estate delivers strong cash flows to a portfolio. These findings are unchanged.

The results of the study also suggest a new direction for research on stock market co movements. Focusing on how international propagation mechanisms change after a shock may not be the most productive approach. Instead, research should focus on why markets are so highly integrated during periods of relative stability, as well as during periods of crisis. Crisis periods could be used as windows to help identify these transmission mechanisms, instead of being interpreted as periods that generate new types of transmission mechanisms. In other words, further empirical research should focus not on why some countries are so

vulnerable during periods of crisis, but why countries are always so vulnerable to movements in other countries. Why do so many markets of such different sizes, structures, and geographic locations generally show such a high degree of co-movement? Does trade with third markets link these diverse countries? Or do other economic fundamentals, such as common creditors, that I have been unable to measure? Or is there an "excess interdependence" across markets in all states of the world? And in this case, what theories could explain excess interdependence?

Further research into contagion effects can achieve an even better understanding of contagion effects between common stock and the market for real estate. Further research can focus on other countries and other timeframes as well as other methods of research used in this thesis. Also, now that contagion effects between the common stock market and the market for real estate is shown, it is useful to research possible contagion effects between the market for common stock and the market for other assets as well. For example, the contagion effects between the common stock market and the market for natural resources such as gold and platinum could be researched because the types of assets are often also used as a risk reducing factor in a portfolio.

Literature references

Glascock, J.L. Luc, C. and So, R.W. 2000. Further evidence on the integration of REIT, bond and Stock returns, Journal of real estate Finance and economics. Vol. 20, No 2,pp. 177 – 194
Gilliberto, S.M. 1993. Measuring Real Estate Returns: the hedged REIT Index. Journal of portfolio management, vol 19, No 3, p. 94-99

Gilliberto, M., and Mengden, A., 1996. REITs and real estate: two markets reexamined. Real estate finance, Vol. 13, No. 1, p. 56-60

Grinblatt, M., Titman, S. andirmers, R., 1995. Momentum Investment Strategies, Portfolio Performance, and Herding: a study of mutual fund behavior. The American economic review. Vol. 85, No. 5, p. 1088- 1105

Gyourko, J. and Linneman, P., 1988. Owner-occupied homes, income-producing properties, and REITs as inflation hedges: empirical findings. Journal of Real Estate Finance and Economics, No. 1, p. 347-372.

Hirschleifer, D. and Hong Teoh, S., 2003. Herd behavior and cascading in capital markets: a review and synthesis. European financial management. Vol. 9., No 1, p. 25-66.

Hoesli, M. Lekander, J. and Witkiewicz, W., 2004. International Evidence on Real estate as a Portfolio diversifier. Journal of Real Estate Research, Vol. 26, No. 2. P. 161- 206

Hudson-Wilson, S., Fabozzi, F.J. and Gordon, J.N., 2001. Why real estate – an expending role for institutional investors. The journal of portfolio management. Special real estate Issue

Ibbotson, R.G. and Siegel, L.B., 1984. Real estate Returns: a comparison with other Investments. Real Estate Economics, Vol. 12, No. 2/3, p. 95-101

Kaminsky, G.L. and Schmukler, S.L., 1999. What triggers Market Jitters? A chronicle of the Asian Crisis, Journal of international Money and Finance. No. 18, p. 537-560.

Kallberg, J.G., C.H. Liu and D.W. Grieg, 1996. The role of real estate in the portfolio application process, Real estate Economics, Vol. 24, No 3, p. 359-477.

King, M.A. and Wadhwani, S., 1990. Transmission of volatitlity between stock markets. The review of financial studies. Vol. 3, No. 1. 5-33.

Kyle, A.S., 1985. Continous auctions and insider Trading. Econometrica, Vol. 5, No 6, p. 315-335

Lang, L.H.P. and Stultz, R.M., 1992. Contagion and competitive Intra-Industry effects of Bankruptcy Announcements. Journal of financial economics. No 32, p. 45-60.

Lee, S.L., 2003. The impact of Real Estate on the mixed Asset Portfolio in periods of financial distress, presented at annual meeting.

Ling, D.C. and Ryngaert, M., 1997. Valuation Uncertainty, Institutional Involvement, and the underpricing of IPOs: the case of REITs, Journal of financial economics, No 43, p. 433-456.

Longin, F. and Solnik, B., 1995. Is the correlation in international equity returns constant: 1960-1990? Journal of international money and finance, Vol. 13, No. 1, p. 3-26

Lux, T., 1995. Herd behavior, bubbles and crashes. The economic journal, Vol. 7, No. 1, p. 77-91.

Mullainathan, S., 2002. A memory based model of bounded rationality, The quarterly Journal of economics. Vol. 117, No. 3, p. 735-774

Poterba, J.M. and Summers, L.H., 1989. Mean reversion in Stock Prices: evidence and implications, NBER working paper

Radelet, S. and Zeckahauser, S., 1983. Rediscover your company's real estate, Harvard Business Review, February.

Sloan, R.G, 1996 Do stock prices fully reflect information in accruals and cash flows about future earnings? The accounting review, Vol. 71, No. 3, p. 289-315.

Wang, K., J. Erickson, S.H. Chan, 1995. Does the REIT Stock Market Resemble the general Stock Market? Journal of real estate research, Vol. 10, p. 445-60

Wilson, P.J., Stevenson, S. and Zurbruegg, R., 2007. Foreign property shocks and the impact on domestic securitized real estate markets: an observed component approach. Real estate fin econ. No. 34, p. 404-424.

Ziering, B., Lian, Y. and Mcintosh w., 199. REIT correlations with capital market indexes: separating signal from noise. Real estate finance, Vol. 14, No. 4, p. 61-67

Hirschleifer, D. and Hong Teoh, S., 2003. Herd behavior and cascading in capital markets: a review and synthesis. European financial management. Vol. 9., No 1, p. 25-66.

Hoesli, M. Lekander, J. and Witkiewicz, W., 2004. International Evidence on Real estate as a Portfolio diversifier. Journal of Real Estate Research, Vol. 26, No. 2. P. 161- 206

Hudson-Wilson, S., Fabozzi, F.J. and Gordon, J.N., 2001. Why real estate – an expending role for institutional investors. The journal of portfolio management. Special real estate Issue

Gilliberto, M., and Mengden, A., 1996. REITs and real estate: two markets reexamined. Real estate finance, Vol. 13, No. 1, p. 56-60

Grinblatt, M., Titman, S. and Irmers, R., 1995. Momentum Investment Strategies, Portfolio Performance, and Herding: a study of mutual fund behavior. The American economic review. Vol. 85, No. 5, p. 1088-1105

Gyourko, J. and Linneman, P., 1988. Owner-occupied homes, income-producing properties, and REITs as inflation hedges: empirical findings. Journal of Real Estate Finance and Economics, No. 1, p. 347-372

Books

Brueggeman, W.B. and Fisher, J.D., 2005 Real estate finance and investments, McGraw Hill Higher education.

Geltner, D. and Miller, N.G. 2001. Commercial Real Estate Analysis and Investments, Southistern, Thomson learning.

Levine, D.M. Berenson, M.L. and Krehbiel, T.C. 2006. Basis Business Statistics – concepts and applications, Pierson Prentice Hall, tenth edition.

List of keywords

Contagion
Conditional correlation
Co integration
Efficient Market Hypothesis
Financial distress
Modern Portfolio Theory
Real Estate Investment Trust (REIT)
Standard deviation
Unconditional correlation
Variance
Volatility

Appendices

Appendix A: Showing the relation between volatility and correlation

In a scenario in which stock market returns behave like stochastic variables, the relationship that describes the returns of the two markets is the one stated below

$$y = \alpha + \beta x_t + \epsilon_t$$

In this formula, further factors that have to be specified.

$$E[\epsilon_t] = 0)$$

$$E[\epsilon_t^2] = c < \infty$$

In the above equation, c is constant.

$$E[x_t\ \epsilon_t] = 0$$

The sample is divided into two groups: a group with a low variance and a group with a high variance

The group with the lower variance resembles the period before a crisis, meaning the period of relative stability and the group of high variance resembles the period after a crises, meaning the period of instability.

From this, it follows that if we assume that $E[x_t\ \epsilon_t] = 0$ the ordinary least squares estimates of equation 1 are consistent for both groups and it follows that $\beta^h = \beta^l$. Added that we can tell that when
$\sigma_{xx}^l < \sigma_{xx}^h$ we add the standard definition of β we get:

$$\beta^l = \frac{\sigma_{xy}^l}{\sigma_{xx}^l} = \frac{\sigma_{xy}^h}{\sigma_{xx}^h} = \beta^h$$

So it follows that: $\sigma_{xy}^h > \sigma_{xy}^l$

The second group thus displays a higher cross variance than the first group does. The increment in the factor of cross variance that is witnessed in the first group is moving along with the increase in the variance of x.

$$\sigma_{yy} = \beta^2 \sigma_{xx} + \sigma_{\epsilon\epsilon}$$

$$\left[\frac{\sigma_{xx}}{\sigma_{yy}}\right]^{l} = \left[\frac{\sigma_{xx}}{\sigma_{yy}}\right]^{h}$$

$$\rho = \frac{\sigma_{xy}}{\sigma_x \sigma_y} = \beta \frac{\sigma_x}{\sigma_y}$$

This systematic breakdown is meant to prove that in a scenario in which the actual relationship between x and y is not changed, a change in the variance of x however will cause a change in the estimated correlation between x and y. This insight warns us for an important shortcoming of hypothesis testing based on correlation coefficients. Since correlation coefficients are shown to be dependent on the variance of x the relative change of x needs to be monitored and weighted in an attempt of clearing the hypothesis testing of this bias of variance increment.

A conditional correlation is needed

$$\boldsymbol{\rho^{*} = p\sqrt{\frac{1+\delta}{1+\delta\rho^{2}}}}$$

In this function, δ represents the relative change of variance of x. ρ represents the unconditional correlation coefficient, and ρ * represents the conditional correlation coefficient.

δ is further specified as:

$$\boldsymbol{\delta = \frac{\sigma_{xx}^{h}}{\sigma_{xx}^{l}} - 1}$$

This breakdown conditional correlation coefficient shows that whenever δ changes, the estimated correlation coefficient is increasing as well. This in turn means that the conditional correlation in financial turbulent times is higher that the unconditional correlation. In a period of high volatility, the conditional correlation will be greater that the unconditional correlation. It causes cross-market coefficients to be biased upwards after a financial shock due to the increased endogenous variable of variance.

If we want to make sure that this upward bias does not cloud the conclusions of our research, we need to account for this bias:

$$\boldsymbol{\rho = \sqrt{\frac{p^{*}}{1+\delta[1-(p^{*})^{2}]}}}$$

$$\frac{r_t^u}{1+\delta\left[1-\left(r_t^u\right)^2\right]})$$

Here r_t^u is the unconditional correlation and r^t the conditional correlation.

Appendix B: Tables indicating robustness test performed

Table B.1. Robustness: sample of the conditional Correlation coefficient									
			Stable period		Unstable period		Increase R	z-statistic	Contagion proven
	Nr.	Crisis	Correlation R	Volatility S (%)	Correlation R	Volatility S (%)			
United States	4	WTC Attack	0.103452	0.010578	0.235	0.008787	0.131548	0.653635	Y
	7	Lehman Brothers Failure	0.566893	0.019554	0.74669	0.0475	0.179797	1.395591	N
United Kingdom	4	WTC Attack	0.116576	0.011706	0.213549	0.017655	0.096973	0.431784	N
	7	Lehman Brothers Failure	0.653755	0.019947	0.72702	0.036221	0.073265	0.608251	N
Australia	1	Early 1990`s crisis	0.145754	0.014271	0.24886	0.018229	0.103106	0.464773	N
	2	Asia crisis	0.054712	0.012869	0.04959	0.018481	-0.00512	-0.02222	N
	6	Credit crunch caused by BNP	0.504145	0.009237	0.662625	0.014398	0.15848	1.049966	Y
	7	Lehman Brothers Failure	0.650442	0.0177	0.75583	0.0258	0.105388	0.910296	N
	8	Collapse of Bear Stearns	0.569554	0.008115	0.717223	0.01025	0.147669	1.104012	N
The Netherlands	3	Russian crisis	0.145261	0.023564	0.245263	0.045263	0.100002	0.445263	N
	4	WTC Attack	0.045264	0.026532	0.035688	0.045261	-0.009576	-0.012563	N
	5	Enron crisis	0.094875	0.014088	0.25357	0.018841	0.158695	0.464773	Y
	7	Lehman Brothers Failure	0.635659	0.020719	0.69494	0.037185	0.059281	0.461333	Y

Table B.2. Robustness: sample of the unconditional Correlation coefficient									
			Stable period		Unstable period		Increase R	z-statistic	Contagion proven
	Nr	Crisis	R	S(%)	R	S(%)			
United States	4	WTC Attack	0.23148	0.015362	0.22833	0.017496	-0.00315	-0.01439	N
	7	Lehman Brothers Failure	0.566893	0.019554	0.74669	0.0475	0.179797	-0.01439	N
United Kingdom	4	WTC Attack	0.504145	0.009237	0.662625	0.014398	0.15848	0.910296	N
	7	Lehman Brothers Failure	0.65044	0.0177	0.75583	0.0258	0.10539	0.789917	N
Australia	1	Early 1990`s crisis	0.036221	0.010578	0.213549	0.008787	0.177328	0.608251	N
	2	Asia crisis	0.53833	0.014352	0.65519	0.017017	0.11686	1.104012	N
	6	Credit crunch caused by BNP	0.14575	0.014271	0.24886	0.018229	0.10311	0.789917	N
	7	Lehman Brothers Failure	0.05471	0.012869	0.04959	0.018481	-0.00512	0.464773	Y
	8	Collapse of Bear Stearns	0.5695	0.008115	0.717223	0.01025	0.147723	1.049966	Y
The Netherlands	3	Russian crisis	0.09487	0.014088	0.25357	0.018841	0.1587	-0.02222	N
	4	WTC Attack	0.63565	0.020719	0.69494	0.037185	0.05929	0.789917	N
	5	Enron crisis	0.05623	0.021301	0.20452	0.056234	0.14829	-0.045265	N
	7	Lehman Brothers Failure	0.61356	0.045231	0.626352	0.045236	0.012792	0.4526325	N