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1 Introduction

The stock market and the house market are two markets with different characteristics, the first one is often more volatile, more liquid and also standardized[1]. The housing market on the other hand is heterogeneous, it is difficult to find two identical objects and it takes time to match buyers and sellers. Even though there exist differences, both markets offer investment opportunities and influences future wealth of households. The purpose of this thesis is to investigate the relationship between the two markets.

According to several authors, the financial crisis of 2007-2008 was the most severe since the great depression in the 1920s (Wheelock, 2010; Crotty, 2009). The stock market decreased heavily during the crisis and wealth deteriorated for stockholders. House prices did also decrease dramatically during the same period. The crisis of 2007 began with a mortgage bubble, so obviously there existed a connection between the house market and the stock market. Was this historical event a coincident or is there a long run *relationship between the stock market and the housing market?* If there is, *which causes*[2] *which?* Potentially there may be a dynamic relationship over time with changes in the direction of the causality. Also, *when do the effect from changes occur and how large is it*? This thesis aims at answering these questions. An analysis of the correlation and causality patterns will be presented. Even if the hypothesis of a relationship is rejected, there are still important conclusions to draw. A weak or possible negative relationship implies that there are diversification benefits for an investor selecting to invest in both types of assets. On the other hand, a positive relationship implies that an increase (decrease) in one market is associated with an increase (decrease) in the other. Consequently, households owning both types of assets are highly exposed to changes in the two markets hence fluctuations in the stock market and the house market could have devastated ramifications for wealth.

This topic is important to highlight since it can aid investors to make better investment decisions. If it is possible to identify a relationship between the two markets and also to analyze the causality, the findings can provide useful information about future changes. American households are potentially highly exposed to the two markets, hence it is necessary to thoroughly understand the relationship in order to restrict large fluctuations of

[1] A standardization in the stock market means that it is possible to buy two identical shares.

[2] In this thesis, the terms "causes" and "causality" refers to if one of the variables (markets) is granger causing the other variable (market).

wealth. These fluctuations may also affect the health of the general economy. Moreover, it is crucial from the perspective of a policymaker to clearly understand how a potential relationship between the two markets works. It is important to be able to analyze the effects on the two markets prior to the implementation of new policies. For example, if policymakers know that house prices will cause the stock market they are also aware of that a change in a factor affecting house prices, such as the interest rate, will influence the stock market.

This study is conducted in the U.S due to several reasons. First, as a consequence of the most recent financial crisis both the house market and the stock market declined, it is interesting to investigate the relationship between the two markets prior and post of the crisis. The relationship may not be constant. Second, previous studies conducted in the U.S are available which gives an opportunity to compare the results. Third, there are several house price indices available which all defines houses and price changes in different ways. The author can therefore select how houses and price changes should be defined/measured. Finally, the size of the American economy is large and it has a significant impact on the world economy. The results from this study may therefore be valid in a number of other countries with a similar distribution of wealth among homeowners and stockowners.

Other studies have been investigating the relationship between the stock market and the house market in the U.S (Okunev et al, 2000; Gyourko & Keim, 1992; McMillan, 2012; Ibbotson & Siegel, 1984; Eichholtz & Hartzell, 1996; Quan & Titman, 1999; Green, 2000) however this study is unique in several aspects. The thesis investigates the relationship between the stock market and *single family houses*. The majority of previous studies includes all different types of real estates which may give another picture of the relationship since many corporations are real estate owners (owning warehouses, office buildings, production plants etc.). Implying that the value of corporations (with properties as a large share of their total value) and thus its stock price, should be highly affected by changes in the value of real estates. Moreover, changes in house prices are estimated with another method. The house price index applied in this thesis is the S&P/Case-Shiller which is based on a *weighted repeated sale methodology.* This study is also conducted in a *different time period* (1987-2013) compared to previous studies. The relationship between the two markets may have changed. The sample period is unique since it includes *two economic booms/recessions* (The Dot-com bubble in the late 1990s and the most recent financial crisis in 2007-2008), it is interesting to examine if the relationship between the two markets have remained constant around both events. Finally, this study will also investigate *how fast and how much the two markets are affected by a potential causality*, rather than "just" determine if a causality exist or not.

Houses can be defined in several different ways and it is vital to have a clear picture of the concept in order to interpret the results correctly. This thesis will use the very same definition of houses as the S&P/Case-Shiller price index does. The index includes *single family houses*. It excludes sale prices associated with constructions, condominiums, co-ops/apartments, multi-family dwellings and other properties that are not identified as single family houses (McGRAW Hill, 2013).

The main findings indicate a strong and positive correlation between the house market and the stock market. The Granger causality test concludes a unidirectional causality running from the stock market to the house market. The impulse response function concludes that a one percentage change in the stock market affects the house market by 0.032581 percent three years later, corresponding to a change in the value of real estates possessed by American households of 7.04 billion of dollars. The same number amounts to 47.00 billion of dollars five years later.

The structure of the thesis is organized as follows, chapter 2 presents background information and a deeper motivation to why the relationship is important to understand. Moreover, historical trends in the two markets are presented. Chapter 3 investigates previous studies. The theoretical framework is introduced in chapter 4. The chapter ends with hypotheses of the relationship. Chapter 5 introduces and motivates the choice of estimators used as inputs in the thesis. Chapter 6 is entitled empirical design, it is devoted to method and statistical tests. A discussion of the results is also presented here. The thesis ends with a conclusion in chapter 7.

2 Background

This chapter starts with an investigation of the balance sheet of American households. By examining the balance sheet it is possible to identify the portion of accumulated wealth consisting of stocks and houses. The same section do also present an investigation of how wealth is distributed. The chapter will also investigate historical movements in the two markets and it ends with a comparison of the historical movements. The purpose of the sections is to develop an understanding of potential structural breaks, special events and potential patterns.

2.1 Accumulated Wealth of American Households

The topic is of great importance if stocks and houses are large components of the total wealth among American households. The topic is still important to investigate even if this is not the case since a change in one of the two markets might predict changes in the other. Investigating the balance sheet of American households provides information of their exposure to the stock market and the house market. The examination shows the percentage of total wealth consisting of stocks and houses. The original data was retrieved from the Board of Governors of the Federal Reserve System (2013). The data has been remodeled by the author, categories that are of minor interest have been consolidated. An overview of the balance sheet of American households is presented in table 1.

Table 1: Balance Sheet of American Households 2013Q3

Balance Sheet of Households and Nonprofit Organizations 2013Q3		
	Billions of dollars	Percentage
Assets	**90938.30**	
Nonfinancial assets	27044.10	29.74
Real estate	21610.90	23.76
Other nonfinancial assets	5433.10	5.98
Financial assets	63894.30	70.26
Deposits	9274.70	10.20
Credit market instruments	5500.10	6.05
Shares	18298.50	20.12
Other financial assets	30821.00	33.89
Liabilities	**13679.00**	
Net worth	**77259.30**	

Source: Board of Governors of the Federal Reserve System, 2013.

Table 1 verifies that real estates and stocks are large components, together they amount of almost 45% of the total wealth. Hence, changes in stock prices and/or house prices could have a significant impact on the wealth among American households. The severity from potential changes depends on the correlation between the two markets. A strong positive correlation increases the risk and simultaneous changes in both markets should have a large effect on total wealth. On the other hand, a low or negative correlation reduces the risk, implying that changes only have a minor effect on total wealth.

The statistics above do not provide information of the number of households owning houses and stocks. Hypothetical, it could be the case that almost all stocks and houses are possessed by a small part of the citizens and changes in the two markets should therefore not affect the wealth of the general population. In 2010, 15.1 % of the families in the U.S had a direct ownership in publicly traded stocks. If also indirect ownership[3] of stocks is included, the same number amounts to 49.9 % (Board of Governorns of the Federal Reserve System, 2012)**.** The rate of homeownership was 67.3 % in the U.S in 2010 (Board of Governorns of the Federal Reserve System, 2012). From this information one can conclude that changes in the two markets should have a significant impact on the wealth of the majority of the American households.

The sections above confirm that houses and stocks are large components of the total wealth of American households. However, the topic is not only of interest for individuals owning both types of assets. It may also be of interest for individuals possessing assets in one of the two markets since movements in one of the markets might predict changes in the other. Moreover, it may also be of importance for individuals not owning any of the two assets today but who plan to be an owner in the near future. The percentage of American households being affected by the relationship should therefore be at least as large as the numbers presented above.

[3] Indirect ownership includes investments in retirement accounts, pooled investment trusts and other managed assets.

2.2 Historical Stock Market Movements

Historical movements of the S&P 500[4] are investigated in order to get an understanding of trends and special events. Figure 1 is a plot of the index value of the S&P 500 from 1987Q1 to 2013Q3. Data is retrieved from Federal Reserve of Economic Data (2014-02-20).

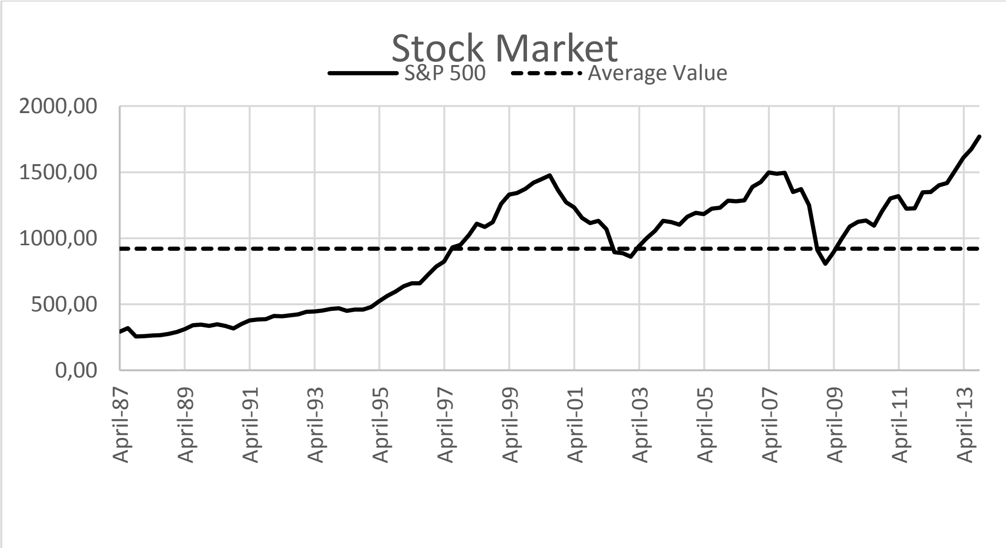

Figure 1: Historical Developments of the Stock Market

Source: Federal Reserve of Economic Data

The S&P 500 increased steadily from 1987Q1 to 1995Q1 and the volatility was fairly low. The index began to increase rapidly after 1995 and it peaked in 2000Q2 after which it decreased quickly. This period is associated with the Dot-com bubble. The volatility of the S&P 500 seems to be larger post of the crisis. The other prominent peak occurred in 2007Q1 and it is associated with the most recent financial crisis. The second peak is slightly larger than the first one with an index value of 1497 and 1476 respectively. The S&P 500 has recovered from the most recent financial crisis and its current value (2013Q3) is above the value in 2007Q1. Prior to 1997Q1, the index value has always been below the average sample value, the opposite is true Post 1997Q1, with two minor exceptions.

[4] The S&P 500 is the second largest stock index in the U.S. It includes 500 stocks (Bloomberg, 2014).

2.3 Historical House Price Movements

A similar analysis of historical house prices is also conducted. The purpose is to get an understanding of historical trends and to identify special events. Figure 2 depicts the S&P/Case-Shiller national index. Data is retrieved from S&P Dow Jones Indices (2014-02-20). The base period of the index is 2000Q1.

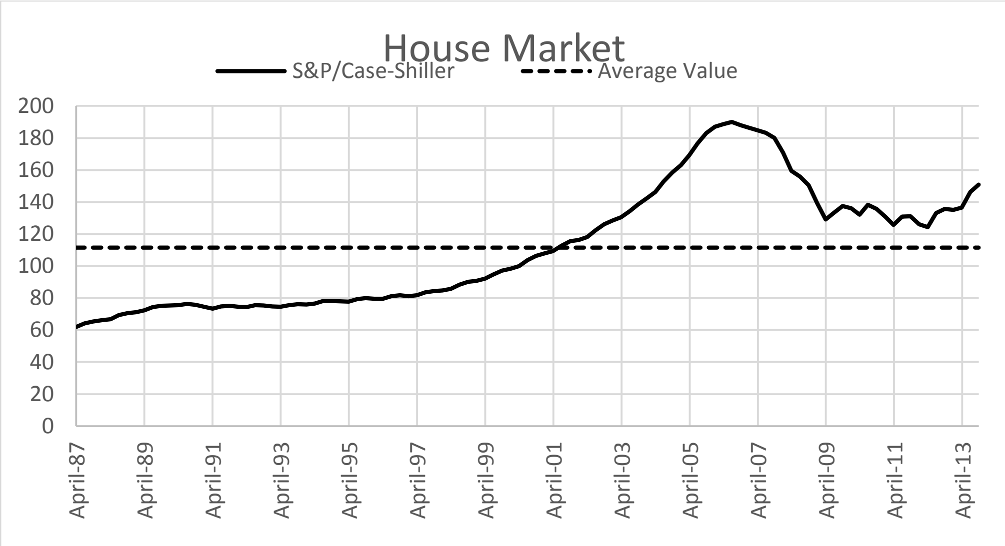

Figure 2: Historical Developments of the House Market

Source: S&P Dow Jones Indices

The figure displays a slow and steady increase of house prices from 1987Q1 to 2000Q1 with a low volatility. Interesting to note here is that the Dot-com bubble had no negative impact on house prices. The index value began to increase rapidly around year 2000, going from a value of 100 to 190 in 6.5 years. The index peaked in 2006Q2 with a value of 190. Shortly after the peak it decreased heavily to a value of 129 in 2009Q1. The volatility of the S&P/Case-Shiller was low prior to the housing bubble and it increased after the crisis. In 2001Q2 the index value increased above the average value. The index level never goes below the average again in the sample period. Historical house prices can be divided into two major periods. The first period is characterized by a steady increase with a low volatility and the second period is associated with a high volatility with no clear trend.

2.4 Comparision of the Stock Market and the House Market

By plotting the two indices in one figure it will be possible to compare them. A graphical examination of historical movements may indicate a relationship. Moreover it will reveal whether the relationship between house prices and stock prices have remained consistently positive, negative or nonexistent. A period with a significant change in the relationship could indicate a structural break. In order to be able to compare the two indices they need to be standardized. The normalized index values[5] are calculated and plotted in figure 3.

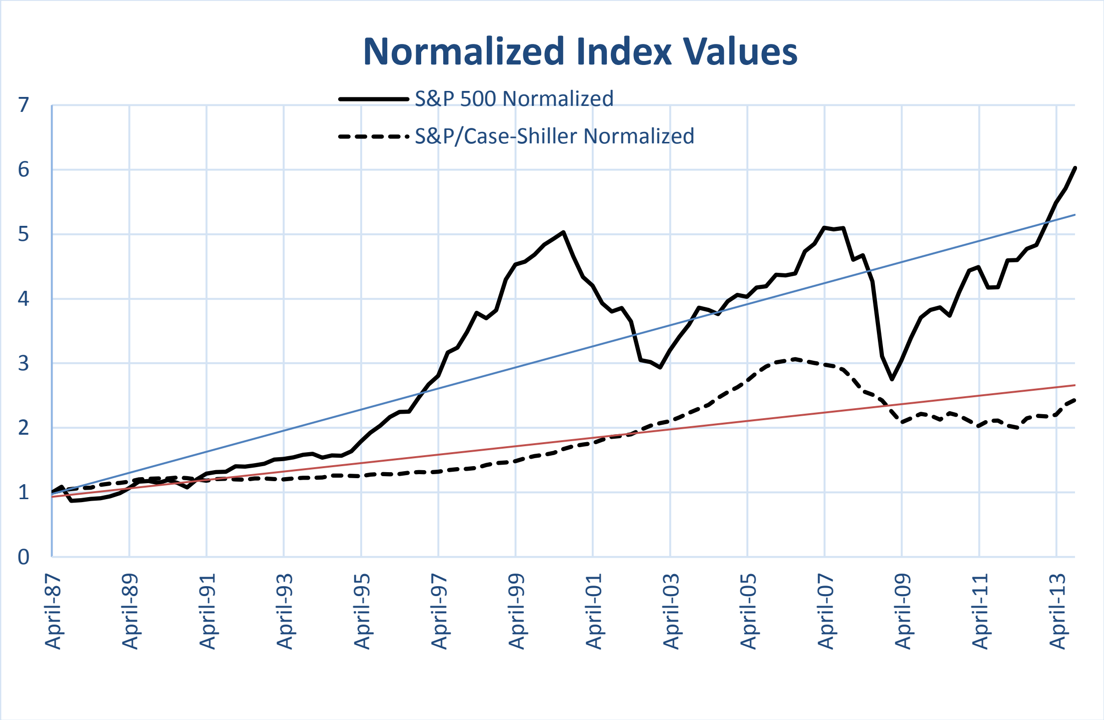

Figure 3: Normalized Values of the Stock Market and the House Market

Source: Federal Reserve Economic Data and S&P Dow Jones Indices. Normalized by author

The normalized index value of the S&P 500 is always above the normalized S&P/Case-Shiller index (except prior to 1991Q1). This indicates that the return from investing in the stock market in 1987Q1 and holding it during the whole sample period is larger compared to investing in houses in the same period. The figure also concludes that the S&P 500 is

[5] The normalized values are calculated by dividing the current index value by the initial starting value of the same index.

more volatile than the S&P/Case-Shiller. The volatility appears to be larger for both indices in the second half of the sample period. A weak positive relation may be identified in figure 3 and it appears to be stronger post 2002. Both indices increased prior to the Dot-com bubble but only the S&P 500 decreased during this crisis. The indices also increased prior to the crisis in 2007. In contrast to the Dot-com bubble, both indices decreased heavily after the most recent financial crisis. The decline of the stock market was larger. The figure indicates that house prices declined prior to the stock market in 2007 which could be an indicator of a unidirectional causality running from the house market to the stock market. On the other hand, only one observation indicates such causality. It could be a coincident or a unique historical event. Trend lines for both series are also plotted. They indicate an increase in both series over time. The increase is larger for the stock market.

3 Previous Research

The chapter presents previous studies of the relationship between the stock market and the house market. 3.1 examines studies of the relationship between two markets focusing on some form of correlation analysis and section 3.1 presents studies examining the causality. The two sections end with a table summarizing previous studies.

The relationship between the house market and the stock market has received much attention in previous research. The findings are ambiguous and explanations to this may be due to differences in statistical methods applied or in the data. Previous studies can be divided into two major categories. The first category examines the correlation between the two markets hence the methods applied are based on a correlation analysis. The other type of research investigates the relationship by using some form of causality test, these studies explains the direction of the causality.

For this thesis, it is especially interesting to consider previous studies conducted in the U.S. However studies conducted in other countries may also be of interest since they might reveal whether the results differ between countries and/or stock markets.

3.1 Research Focusing on Correlation Analysis

The correlation between two assets is a significant factor affecting investment decisions. The term correlation refers to how assets move in relation to one another. A high correlation is associated with a high level of risk. A common objective among investors is to strive after achieving the lowest possible correlation. The correlation between houses and stocks has been examined by several authors and the results are mixed. Quan and Titman (1999) conducted a time series study in 17 countries[6] with data from 1984 to 1996. In addition to stock prices and real estate prices, their model also included GDP, interest rates and inflation as control variables. They found the relationship to be insignificant in 16 of the 17 countries. To investigate the issue further, the data was pooled together over a longer period of time. The cross-sectional study indicated a significant positive correlation. Ibbotson and Siegel (1984) examined the correlation between the returns from real estate prices in the U.S and the returns of the S&P 500 from 1947 to 1982. The correlation coefficient was found to be negative and significant (-0.06). Eichholtz and Hartzell (1996) conducted a similar study in a later time period (1978-1993). An appraisal based index

[6] The Netherlands, Spain, Belgium, Germany, France, Italy, the U.K, Australia, New Zeeland, Malaysia, Japan, Singapore, Hong Kong, Taiwan, Thailand, Indonesia and the U.S.

(RUSSELL-NCREIF) was used as the estimator of real estate prices in the U.S and the S&P 500 represented stock market movements. The correlation was investigated with an ordinary least squares regression model. They found a negative and significant correlation coefficient (-0.09) between the S&P 500 and the RUSSELL-NCREIF index. Eichholtz and Hartzell (1996) did also investigate the correlation in Canada and the U.K, the results were similar to the regression model for the U.S. They found a significant negative correlation coefficient of -0.1 and -0.08 respectively. Moreover, the relationship between property shares (which are similar to real estate investment trust) and the stock market on which they were listed was also investigated in the U.S. The results revealed a strong positive relationship (Eichholtz & Hartzell, 1996). Table 2 summarizes previous studies on correlation analysis.

Table 2: Previous Studies Based on Correlation Analysis

Study	Estimator of house prices	Estimator of stock prices	Country investigated	Period	Method	Results
Quan and Titman (1999)	Capital values and rental indexes of prime office buildings (appraisal based)	Morgan Stanley's capital International´s composite stock return indexes	17 countries [7]	1984-1996	Cross-sectional regression and time series regression[8]	Cross-sectional: a significant positive relationship Time series: no relationship
Ibbotson and Siegel (1984)	Business, farm and residential real estate (appraisal based)	S&P 500	The U.S	1947-1982	Cross- and serial correlation of assets total returns	Negative correlation
Eichholtz and Hartzell (1996)	Property shares[9] and various types of real properties[10] (appraisal based)	Toronto stock exchange composite index, financial times actuaries all share index and S&P 500	Canada, the U.K and the U.S	For Canada: 1985-1993 For the U.K: 1977-1993 For the U.S:	Ordinary least squares regression model and impulse response analysis	Positive correlation between property shares and stock market. Negative correlation be-

[7] The Netherlands, Spain, Belgium, Germany, France, Italy, the U.K, Australia, New Zeeland, Malaysia, Japan, Singapore, Hong Kong, Taiwan, Thailand, Indonesia and the U.S.
[8] The models included GDP, interest rates and inflation as control variables.
[9] The property shares investigated: Datastream property share index, financial actuaries property share index and REIT of Wilshire.
[10] Included in various properties are apartments, hotels, industrial, office and retail properties and sub-types within each category.

				1978-1993		tween property index and stock market

3.2 Research Focusing on Causality

The correlation analysis do not explain the full relationship, it lacks information about the causality. A causality exists if one event causes another event. The time perspective is important, it is not possible for event B to Granger cause A if event B occurred post event A. However, event A may Granger cause event B. The causality between the stock market and the house market has received much attention in previous studies. Okunev et al. (2000) applied a nonlinear Granger causality test to investigate the causality between real estate investment trust (REIT) and the S&P 500. They concluded a unidirectional causality[11] running from the stock market to the real estate market during the sample period (1972-1998). Gyourko and Keim (1992) used the same type of data (S&P 500 and REIT). Their study was conducted during a shorter period of time (1978-1990) and they did also conclude a unidirectional causality running from the stock market to the real estate market. Green (2002) investigated the causality in four counties in California. Monthly data from 1989 to 1998 of the Russell 2000 stock index and houses prices from California Association of Realtors of San Francisco County, Santa Clara County, Los Angeles County and Orange County were used as estimators. The California Association of Realtors define houses as single family homes. Green (2002) concluded that house prices did not cause Russell 2000 for any of the four counties investigated. However, the Russell 2000 was found to cause house prices in two of the four counties. Hence a unidirectional causality running from the stock market to the house market existed for two of the four counties and the causality between the other two counties was independent[12].

Kakes and Van Den End (2004) investigated the causality in the Netherlands from 1985 to 2002. The generalized impulse response function and the variance decomposition, estimated from a vector autoregressive model, indicated that changes in the stock market caused changes in the house market. Except for real house prices and the AEX stock market index, the vector autoregressive model did also included real disposable income and interest rates as control variables. Ibrahim (2010) conducted a similar study in Thailand. He concluded, by applying the Granger causality tests, an impulse response function

[11] A unidirectional causality exists when variable X influences variable Y, but Y do not influence X.
[12] Independence exists when none of the variables influences each other.

and variance decomposition, that the stock market caused the house market during the sample period (1995-2006).

Su et al. (2011) applied a non-linear causality test based on a threshold auto-regressive model. The sample period reached from 2000 to 2007. A unidirectional causality running from the real estate market to the stock market was evident in the U.K and the Netherlands. The opposite, a unidirectional causality running from the stock market to the real estate market, was present in Belgium. A bilateral causality[13] was discovered in Spain and France. McMillan (2012) did also found a unidirectional causality running from the house market to the stock market. He tested the causality between the real estate market and the stock market in the U.S and the U.K using an ESTR model[14]. Data for real estate prices in the U.S was estimated by the Census Bureau and the sample period reached from 1974 to 2009. The S&P 500 was the estimate of stock market movements. Table 3 summarizes previous studies on the causality.

Table 3: Previous Studies Based on Causality Tests

Study	Estimator of house prices	Estimator of stock prices	County investigated	Period	Method	Results
Okunev et al. (2000)	REIT	S&P 500	The U.S	1972-1998	Non-linear causality test	Unidirectional causality running from the stock market to the real estate market
Gyourko and Keim (1992)	REIT and various different types of properties[15] (Russell NCREIF index: appraisal based)	S&P 500	The U.S	1978-1990	Correlation analysis, regression analysis with lagged values of stock market	S&P 500 predicts returns on real estate portfolios and returns on appraisal-based index
Green (2000)	Single family homes (median price based index)	Russell 2000	The U.S, California	1989-1998	Granger Causality test	A unidirectional causality running from the stock market to the house market for two of the counties. The other two was

[13] A bilateral causality, or feedback, exists when the variables causes each other.
[14] Exponential smooth transition model.
[15] Included in various properties are apartments, hotels, industrial, office and retail properties and sub-types within each type.

						found to be independent.
Kakes and Van Den End (2004)	Real house prices and its subcategories (Dutch NVM index: median price based)	AEX stock index	The Netherlands	1985-2002	Generalized impulse response and variance decomposition estimated from a VAR model[16]	A unidirectional causality running from the stock market to the house market
Ibrahim (2010)	Semi-detached houses (with/without land) and townhouses (with/without land)	Stock exchange of Thailand composite index	Thailand	1995-2006	Granger causality test, impulse-response function and variance decomposition, based on a VAR model[17]	Unidirectional causality running from the stock market to the house market
Su et al. (2011)	Not specified[18]	Not specified[19]	The U.K, the Netherlands, Belgium, France and Spain	2000-2007	Granger causality test based on a threshold error-correction model	Mixed[20]
McMillan (2012)	mortgage data for properties[21] and single family houses[22]	FT-ALL share index and S&P 500	The U.S and the U.K	1974-2009	ESTR[23] model and an error correction model	Unidirectional causality running from the house market to the stock market

[16] The VAR model included stock prices, real house prices, real disposable income and ten year government bond yield.

[17] The VAR model included stock prices, house prices, real output and consumer prices.

[18] Not mentioned, only explain that the data was retrieved from the institute of physical planning and information database and the DataStream database.

[19] Not mentioned, only explain that the data was retrieved from the institute of physical planning and information database and the DataStream database.

[20] A unidirectional causality running from the real estate market to the stock market was eivident in the U.K and the Netherlands. A unidirectional causality running from the stock market to the real estate market was concluded in Belgium. Feedback was discovered in Spain and France.

[21] Estimates by the Nationwide are based on mortgage rates on U.K properties.

[22] Estimates from the house market in the U.S are based on a media price index technique.

[23] The estimated ESTR model (exponential smooth-transition model): $\Delta Y_{i,t} = (\theta_0 + \alpha_i Y_{i,t-1} + \beta X_{t-1}) + (\beta_{ESTR} X_{t-1}) * (1 - \exp(-\beta X_{t-1}^2)) + \varepsilon_t$ Where $Y_{i,t}$ is the stock and house price series, X_t is the error correction term.

4 Theoretical Framework

This chapter starts with a presentation of three theories that may explain the direction of the causality. Section 4.2 introduces information about the size and timing of a potential causality. Section 4.3 provides Information and a discussion of factors affecting both the stock market and the house market. The chapter ends with hypotheses of the relationship.

4.1 Causal Relationship

There are three major theories that may explain the causal relationship between the stock market and the house market. The first one is the *wealth effect*, where houses are assumed to be a consumer good. The second theory origins from *modern portfolio theory* and emphasizes the need of rebalancing the portfolio if the market value of the assets included in the portfolio changes. The last theory presented is the *credit-price effect*.

4.1.1 Wealth Effect

The wealth effect suggests that changes in asset prices affect the net wealth of households, which in turn influences their consumption (McDowell et al. 2012). As concluded previously, stocks and houses are a large share of the net wealth of households and changes in the value of both of them should influence consumption. This theory holds if houses are assumed to be a consumer good. The price of consumer goods, and thus houses, is determined by demand and supply. Since it takes time to construct new houses, the supply of houses is assumed to be fixed in the short-run. An increase in demand for houses is therefore assumed to boost house price.

The level of current consumption is determined by expectations about future wealth (Case et al. 2012). Future wealth and consumption can be explained by the life-cycle hypothesis (LCH), introduced by Brumberg and Modigliani (1954). According to the LCH, households strive to maintain a constant level of consumption even though their income changes at different stages of the life. Households predict their future wealth and plan its consumption (Dornbusch et al. 2011). The choice of a household's consumption of houses is therefore already decided. Only an *unanticipated* change in net wealth should affect the consumption. Hence, unexpected changes in the stock market and/or the house market influence the consumption of houses. According to the permanent income theory (PIT), the change in net wealth needs to be *permanent* in order to affect consumption (Dornbusch et al. 2011). To simplify the analysis, the stock market is assumed to follow a random walk. Hence the best estimate of its future value is the present value (Gujarati &

Porter, 2009). All changes in the stock market are therefore assumed to be permanent and unanticipated. A permanent unanticipated change in the value of stocks and/or houses affects the wealth of households which in turns influences their consumption of houses. This influences the demand for houses and thus the price as well. The stock market is not affected by changes in net wealth, stocks are an investment and not a consumer good. According to the wealth effect, the level of investment is not affected by changes in net wealth. Moreover, the value of stocks is not determined by demand and supply, rather it is based on expectations about future cash flows, the risk and the discount rate associated with it (Damodaran, 2012). *The wealth effect suggests a unidirectional causality running from the stock market to the house market.*

The wealth effect has been documented in the past. In the late 1990s, the rapid increase in the American stock market and the boom in the housing market (2003-2005) increased the net wealth of American households and thus their consumption increased. The opposite occurred when the two markets declined in 2009 and 2010 (Case et al. 2012).

In practice, it is difficult to realize the profit/loss before the asset is sold. To realize a profit, and thus to be able to consume more today, households can borrow the same amount of money as the profit. Even if a household have not realized the profit they perceive themselves as wealthier which make them consume more today (McDowell et al. 2012). The LCH and the PIT do not account for liquidity constrains, individuals are assumed to be able to borrow money in times when their income is low. The theories also assume that households perfectly plan their future consumption (Dornbusch et al. 2011). These assumptions may not be realistic in practice, however they are assumed to hold in this thesis.

4.1.2 Modern Portfolio Theory

Modern portfolio theory, introduced by Markowitz (1952), focus on the expected return and the expected variance (risk) of a portfolio. The objective is to maximize the expected return, given a predetermined variance or to realize a predetermined expected return with the lowest possible variance. The theory emphasizes that the investor should evaluate the asset´s contribution to the portfolio´s overall risk and return rather than evaluating each asset individually. By looking at the overall contribution it is possible to control for a desirable level of expected return and expected variance. To achieve this, the investor puts different weights to the assets in the portfolio depending on his/her objective (Elton et al. 2011).

If the value of stocks or houses changes, the weights in the portfolio shift. Hence the expected return and variance is affected. If the holder of the portfolio is unhappy with this new distribution he/she needs to rebalance the portfolio which is achieved by selling/purchasing assets. To simplify the analysis, it is assumed that the household's portfolio consists of only stocks and houses and the only way to shift weights is to increase/decrease the holdings of these two assets. It is also assumed that the holder´s objective is to keep constant weights. In other words, the holder of the portfolio wants a constant risk and return distribution.

An increase in stock prices increases the value of stocks in the portfolio which disturbs the weights. To rebalance the portfolio and to keep constant weights, the portfolio manager must decrease the holdings of stocks and increase the holdings of houses. The demand for houses increases and thus the price should increase. According to the reasoning above, the two markets do affect each other. However, the house market should not affect the stock market since the price of stocks is not determined by demand. The value is based on future cash flows, the risk (discount rate) and the level of growth associated with it (Damadoran, 2012). *Modern portfolio theory suggests a unidirectional causality running from the stock market to the house market.* This statement is also true if stocks are assumed to follow a random walk. The best estimate of its future value is the present value, regardless of changes in demand.

4.1.3 Credit-Price Effect

A unidirectional causality running from the house market to the stock market exist if the credit-price effect is present. A large part of the majority of firms´ balance sheets consists of real estates. A change in the value of real estates should therefore have a significant impact on the value of firms and thus its stock price. Changes in the value of real estates do also influence the creditworthiness of firms. An increase in the value of the real estates increases the creditworthiness of firms and they can borrow more money and thus invest more. These investments should increase the performance of the firm, implying that cash flows and thus the stock price appreciates. Moreover, the increased demand for real estates should boost property prices even further (Lean, 2012; Sim & Chang, 2006; Kapopoulos & Siokis, 2005). The credit-price effect suggests a unidirectional causality running from the real estate market to the stock market. However this study investigates the relationship between the stock market and *single family houses*. The study excludes other properties and the credit-price effect is therefore not expected to be present.

4.2 Size and Timing of the Causality

Many of the previous studies investigating the causality between the stock market and the house market do not provide information about the size and timing of the causality. This thesis will provide such information and the best way to gain information of the size and timing of the causality is to look at the few previous studies available investigating the issue.

Sim and Chang (2006) found a unidirectional causality running from the house market to the stock market. They used a generalized impulse response function to test how the stock market reacted to shocks in house prices and land prices in Korea. They concluded that the stock market reacts immediately to shocks in house prices and land prices. Ibrahim (2010) examined the relationship in Thailand and concluded that the stock market caused the house market. The impulse response function indicated that changes in the stock market influences the price of semi-detached houses without land immediately while the effect on semi-detached houses with land and townhouses with and without land became significant after four to seven quarters.

Kakes and Van Den End (2004) studied the relationship in the Netherlands. They used a variance decomposition to prove that changes in equity prices do explain large parts of the variation in house prices twelve quarters later. An impulse response function was also estimated. The result indicated that house prices responded with an elasticity of 25 % three years after the shock in equity prices. Sutton (2002) conducted a study where the effects on the house market from shocks in the equity market were quantified. A VAR model including house prices, equity prices, national income and interest rates was estimated. He investigated how house prices was effected by a 10 % change in equity prices. One year after the shock, house prices changed by approximately 1 % in Canada and Ireland, the same number amounted to 0.3 % for the U.S. The effect on house prices in the U.K, the Netherlands and Australia was 1.5 %, 0.2 % and 0.7 % respectively. Three years after the shock in equity prices, house prices increased by approximately 1 % in the

U.S, Canada and Ireland. House prices in Australia and the Netherlands increased by roughly 2 %. The effect was largest in the U.K where house prices increased by approximately 5 % three years after the shock.

4.3 Common Factors Influencing the House Market and the Stock Market

The intuition behind this section is to present underlying fundamentals affecting both house prices and stock prices such as the interest rate and national income. This section will provide valuable information that is useful when developing hypotheses of the relationship. Moreover, the section will also identify potential factors affecting the causality. It will be possible to investigate whether a potential causality between the stock market and the house market exist due to common underlying fundamentals or if the two markets causes each other with the effects from these fundamentals removed.

There are of course other factors also influencing the two markets. Due to limitations of space and the fact that this is a master´s thesis, it is not possible to treat all variables affecting the two markets. Inflation has been argued to influence both the stock market and the house market. However, the variable is excluded in this study. Previous studies investigating the issue (for example Kakes & Van Den End, 2004; Ibrahim, 2010) have not included the inflation either. Hence the exclusion of the inflation makes it more convenient to compare the results. Moreover, it could be argued that some of the effect from inflation is captured in the nominal GDP, which is one of the control variables included in this thesis.

4.3.1 Interest Rate

Investments, such as stocks and houses, are highly affected by the interest rate. The risk free rate is often the benchmark for returns of more risky investments. The level of interest do also affect the present value and it is therefore important to take it into consideration before making any investment decisions. Interest rates and asset returns should have a positive relationship according to the capital asset pricing model (CAPM). According to the CAPM, investors hold only two types of assets, risky assets (such as houses and stocks) and riskless securities. The investor combines these two types of assets in order to achieve a desirable risk-return distribution. In equilibrium, the return on an efficient portfolio is determined by the market price of time and the market price of risk multiplied by the exposure to the risk (Elton et al. 2011). The CAPM describes the return on an efficient portfolio while the Security Market Line (SML) determines the return on an individual security. The SML is based on the CAPM, equation 1 below describes the SML (Elton et al. 2011):

$$\bar{R}_i = R_F + \beta_i(\bar{R}_M - R_F) \qquad (1)$$

$\bar{R}_i$: Expected return on security i
R_F: Risk free rate
β_i: Beta of security i
$\bar{R}_M$: Expected return on market

The first component of the equation is the risk-free rate. If the risk-free rate increases, the return on the security should also increase. Hence house prices and stocks should both be positively related to the interest rate. However, the interest rate is also a component of the discount rate which influences the present value of stocks (Damodaran, 2012). A high level of interest increases the discount rate which in turn lowers the fundamental value of the asset. Stocks and interest rates should have a negative relationship according to fundamental stock valuation. The results from empirical studies investigating the relationship are mixed. Uddin and Alam (2007) found a significant negative relationship between interest rates and stock prices. Hissing (2004) do also support this negative relationship. Lee (1997) conclude an unstable relationship over time with a change from a significant negative relation to no relation at all. Alam and Uddin (2009) examined the relationship in 15 countries and concluded that the hypthesis of a negative relationship could not be rejected. However, for this thesis, it is of less importance to determine the nature of the relationship. More important is to determine that interest rates actually influence stock prices.

The theory of user costs of housing and rents, presented by Nakajima (2011), states that changes in the costs of owning the house should affect the price of the house. Interest payments (or opportunity cost), maintenance and repairs of the house and expectations about future prices are all parts of the user cost. The user cost of owning a house affects the demand for the house. A high user cost is associated with a low demand which in turn implies a lower price for the house. How much the interest rate affects the user costs depends on the size of the interest payments in relation to the other costs of owning the house. Interest payments (or the opportunity cost) should be a large share of the user costs for an expensive house. An increase in the interest rate is associated with an increase in the user cost. Therefore interest rates and house prices should have a negative relationship, which is contradictive to the CAPM. However, empirical studies have found a significant negative relationship between interest rates and house prices (Sutton, 2002; Harris, 1989; Peek & Wilcox, 1991).

4.3.2 National Income

Except for the interest rate, the national income is also included as a control variable. The inclusion of control variables will provide more information about the relationship. It will be possible to determine whether the relationship exists due to common underlying fundamentals or if a relationship also exists with these effects removed. The national income is an indicator of the state of the general economy. The national income can be measured in several ways where GDP is a common approach. The GDP influences both the house market and the stock market. It has been documented that growth in national income is positively related to changes in house prices (Sutton, 2002; Case & Shiller, 2003). Englund and Ioannides (1997) found the one year lagged GDP growth rate to be significant for explaining house price dynamics. Sutton (2002) concluded that changes in the stock market have an impact on house prices. He explained that equity prices may forecast changes in national income which in turn affects house prices. The national income should also affect the cash flow of firms. A change in the national income affects individuals income and their consumption. Changes in consumption are closely related to a firm´s revenue and cash flow. Thus national income and stock prices should be positively related. Levine and Zervos (1996) and Mohtadi and Agarwal (2001) investigated the relationship between national income and stock prices. Both studies concluded a significant positive relationship.

4.4 Hypotheses

Hypotheses are developed based on previous research and theories reviewed. The thesis aims at investigating three hypotheses. First, is there a relationship between the house market and the stock market in the U.S?

Previous research has investigated the correlation among the returns of the stock market and the house market. These returns were found to have a low/negative correlation. This thesis will investigate the relationship between the actual index values hence the relationship may be different. Figures of historical movements of the two markets indicate a slightly positive relationship. Also the two markets react to common underlying fundamentals in a similar way. The only indicator of a negative relationship may be the interest rate. The two markets could be negatively correlated if the interest rate has a large influence on both the stock market and the house market. However, there are more factors indicating a positive relationship and these factors may have a stronger effect than the interest rates.

Hypothesis 1: There exists a positive relationship between the house market and the stock market in the U.S.

The thesis will also investigate the causality and according to both the wealth effect and modern portfolio theory, the stock market should cause the house market. It do not matter if houses are classified as a consumer good or an investment, the direction of the causality should not change. Moreover, since the value of stocks is not determined by supply and demand, stock prices should not be affected by neither the wealth effect nor the modern portfolio theory.

Hypothesis 2: There exist a unidirectional relationship running from the stock market to the house market.

The third hypothesis relates to the size and timing of a potential causality. Empirical evidence is weak and ambivalent. There is also a lack of theories explaining the size and timing of the causality between the stock market and the house market. The hypothesis developed origins from empirical evidence combined with authors own predictions.

Hypothesis 3: Assuming the second hypothesis is accepted, a permanent and unexpected shock in the stock market affects house prices immediately and the full effect is attained sometime after one year. The elasticity of house prices due to a shock in the stock market is between 10 % and 25 % twelve quarters after the shock.

5 Data

This chapter introduces the main inputs in the study. It starts with a motivation of why the S&P 500 is used as an estimate of stock prices followed by a thorough discussion of different techniques for measuring house prices. The chapter ends with a presentation and a discussion of the S&P/Case-Shiller, which will be applied as an estimate of house price movements.

5.1 Stock Market Index

This thesis investigates the relationship between the stock market and the house market at the national level in the U.S. Hence, estimators of stock market movements needs to reflect general stock market fluctuations in the whole U.S. The *S&P 500* meets this criterion. The index contains 500 stocks from all major industries in the U.S. The purpose of the index is to measure the performance of the general economy in the U.S (Bloomberg, 2014). Moreover, the majority of previous research conducted in the U.S has used this index as an input hence it offers an opportunity to compare the findings with earlier studies (Ibbotson & Siegel, 1984; Eichholtz & Hartzell, 1996; Okunev et al. 2000; Gyourko & Keim, 1992; McMillan, 2012).

Quarterly data of the S&P 500 is collected. The value reported is the average S&P 500 value for the last three months. The reported house price index value reflects market movements for the last three months. Hence the reported stock market value should not only reflect what happens in the end of the period, it should be an average for the whole three month period.

5.2 House Price Index

There are several difficulties encountered when measuring house price changes. The difficulties arises mainly due to infrequent trades, non-constant quality of houses/neighborhoods and the fact that houses are heterogeneous. These factors make it problematic to estimate "true" house price movements. Several house price indices have been developed with different methodologies to encounter these difficulties. Extensive research has been devoted to examining the different methodologies.

Real estate investment trust (REIT) is commonly used as an estimator of real estate price changes in previous studies, see for example the work of Okunev et al. (2000) and Gyourko and Keim (1992). The index solves the problem of infrequent trades and comparable indices can be found in several countries. However, REIT and stocks have similar characteristics. REIT is traded on the stock exchange, they offer a relatively high liquidity and no maintenance or repairs is needed. This could be an explanation to why the REIT is closer related to movements in the stock market than other estimators of real estate prices (Eichholtz & Hartzell, 1996). Also the volatility of REIT is larger compared to real estate prices (Firstenberg et al. 1988). The index is not suitable for answering the hypotheses in this thesis since it includes more than single family houses. For example, shopping centers, office buildings, apartments, warehouses and hotels are often included in this index.

Other price indices applied in previous studies are based on the appraisal methodology. This methodology tends to have a smoothing effect and price inadequacies might be present (Chau et al. 2001; McAllister et al. 2003). Indices based on this methodology may therefore give a deceptive picture of price movements. The repeated sales price methodology is another common approach for measuring house prices. It has received criticism for not taking depreciation and changes in the quality of the house/neighborhood into account. Due to this the methodology may be unreliable (Case et al. 1991). Moreover, since the index only includes repeated sales it wastes data. It may also be the case that houses sold repeatedly are not a representative sample of the population (Case & Shiller, 1987).

All indices define houses in different ways, the purpose of this thesis is to investigate the relationship between the stock market and *single family houses*. The index applied in this thesis must therefore only include single family houses. The index should also reduce/avoid the shortcomings introduced above. The *S&P/Case-Shiller national house price index* meets these criteria and will therefore be applied as an estimate of house price movements. Each observation represents the sales pairs that particular month and the two preceding months. For example, the data point for March is based on sales pairs in January, February and March (McGRAW Hill, 2013).

The S&P/Case-Shiller is based on the repeated sales price methodology and it puts four different weights to each sales pair. Firstly, all sale pairs included in the index are weighted according to *price anomalies*. If the price of a sale pair is far away from the statistical distribution in that particular area, the sale pair receives a lower weight hence the influence on the total index value is low. This removes some of the effects from changes in the quality of the house/neighborhood. It also eliminates potential recording errors. Secondly, the index weights according to *turnover frequency*. Houses that are sold more than once during a six month period are excluded. This eliminates fraudulent transactions and non-arm´s-length transactions[24]. Thirdly, it puts different weights on each sales pair depending on the *time interval* between the first and the second transaction. A longer time period is usually associated with changes in the quality of the house, transactions with a long time interval will therefore receive a lower weight. Lastly, the index puts a weight on all sale pairs according to the *initial home value* (McGRAW Hill, 2013). The major criticism of the repeated sales price methodology is reduced due to the different weighting schemes, hence the index should be reliable and track price movements well. The S&P/Case-Shiller is widely known and used, for example the *office of federal housing enterprise oversight* uses it (McGRAW Hill, 2013).

The problem with the waste of data is not expected to generate problems. The number of observations available at the national level is large and the exclusion of houses that are not repeated sales should therefore not have a significant impact on the national index level. Unfortunately it was not possible to find data of the number of houses sold or information on the number of repeated sales included in the index. Statistics of the number of houses sold in the U.S are obviously available, but it is difficult to draw any conclusions from it. The S&P/Case-Shiller and other institutions do not define houses in the very same manner, hence the data can not be compared. The reader needs to be careful and have in mind that this method only includes repeated sales and may therefore not be a representative sample of the full population.

[24] A non-arm´s-length transaction arises when two associates in a transaction have a relationship to each other and they do not act independently of the other individual.

6 Empirical Design

This chapter includes methods, results and a discussion of the results. It starts by introducing descriptive statistics followed by a bivariate correlation matrix analysis. Section 6.3 to 6.6 is devoted to the Granger causality test. Initially, the causality between the stock market and the house market is tested. The very same test is also applied with control variables included. Section 6.6 divides the full sample into two periods and the Granger causality is once again applied. The chapter ends with a discussion of the practical implications of the results. If nothing else is stated, all tests are performed at the 5% level of significance.

6.1 Descriptive Statistic

To get an understanding of the distribution of the variables it is helpful to investigate descriptive statistics. This examination will for example reveal whether the variables are normally distributed or not. The mean, median, maximum, minimum, current value and standard deviation for each variable is presented. Descriptive statistic for the full sample period, including 107 observations, can be seen in table 4 below.

Table 4: Descriptive Statistics (n=107)

	S&P 500	**S&P/Case-Shiller**	**Interest rates**	**GDP**
Mean	921.23	111.51	3.60	10366.68
Median	1056.45	103.77	4.25	10283.70
Maximum	1768.67	189.93	8.54	16912.90
Minimum	255.70	62.03	0.01	4735.20
Current Value (2013Q3)	1768.67	150.92	0.03	16912.90
Standard Deviation	426.73	37.68	2.41	3683.46

The S&P 500 and the GDP are currently at their all-time high, indicating that the American economy has recovered from the most recent financial crisis. The S&P/Case-Shiller is well above its mean value but the index has not recovered from the financial crisis of 2007 yet. The interest rate is close to its minimum value. The standard deviations for the variables are quite high. Some of the variables are volatile in nature (stock market). The sample period includes two economic cycles which may also contribute to the high standard deviations. The standard deviation of the house market is relatively low compared to the other variables.

The mean value of the S&P 500 and the interest rate is lower than the median value, indicating that the variables are negatively skewed. The opposite is true for the S&P/Case-Shiller and the GDP. Hence the variables may not be normally distributed at their initial index values. The coefficients are still unbiased and efficient even if non normality is present. However, the t and the F tests may give misleading results. The assumption of normality is of less importance if the sample size is large (Gujarati & Porter, 2009). There are 107 observations available for each variable hence a potential violation of the normality assumption should not influence the validity of the results.

6.2 Bivariate Correlation Matrix Analysis

By examining the correlation between the stock market and the house market it is possible to accept or reject the hypothesis of a positive relationship. This investigation is necessary in order to get a full understanding of the relationship, the Granger causality test will not provide information regarding whether the relationship is positive or negative. A bivariate correlation matrix is therefore calculated for the S&P 500 and the S&P/Case-Shiller at their initial index values. The bivariate correlation matrix also includes GDP and interest rates at their initial index values as well. The bivariate correlation matrix is presented in table 5. Significant correlation coefficients, at the 1 % level, are marked by an asterisk.

Table 5: Bivariate Correlation Matrix

	S&P 500	**S&P/Case-Shiller**	**GDP**	**Interest rate**
S&P 500	1.000000			
S&P/Case-Shiller	0.769509*	1.000000		
GDP	0.865537*	0.862186*	1.000000	
Interest rate	-0.547318*	-0.554357*	-0.781237*	1.000000

The S&P 500 and the S&P/Case-Shiller are strongly positively correlated and the correlation coefficient is significant. The two variables are also strongly positively correlated with GDP and the size of the correlation coefficients is approximately equal. The interest rate is negatively correlated to all variables. Also here, the size of the correlation coefficient between interest rates and the S&P 500 and the S&P/Case-Shiller is approximately equal. All correlation coefficients presented are significant.

The bivariate correlation matrix indicates a large and positive correlation coefficient between the stock market and the house market. Figures presented in section two do also indicate a positive relationship. The two markets react to common underlying fundamentals in a similar way. This finding is somewhat contradictive to previous studies (Eichholtz and Hartzell, 1996; Ibbotson and Siegel, 1984) which all discovered a low or negative correlation. The contradictive result can be explained by differences in statistical methods. Instead of using a bivariate correlation matrix analysis some of the other studies have analyzed the correlation by using some form of a regression model. Also, previous studies have investigated the correlation among the *returns* from the two markets. This study investigates the correlation between the nominal index values. Moreover, this study is conducted in a completely different time period hence the relationship may have changed.

When it comes to concluding whether the S&P 500 and the S&P/Case-Shiller are positively related or not one have to decide how the correlation should be defined. The correlation between the indices nominal values in the sample period is large and positive, however the correlation among the returns could be different. The hypothesis of a positive relationship between the house market and the stock market is therefore accepted. Quan and Titman (1999) support this conclusion, their cross-sectional study indicated a strong positive correlation.

6.3 Granger Causality

The correlation coefficient is a standardized measure of the degree of linear association between variables. Since the correlation coefficient from the bivariate correlation matrix does not necessarily mean that one of the variables causes the others, a correlation analysis is only helpful when it comes to getting an indication of the nature of the relationship (Aczel & Sounderpandian, 2009). To fully address the purpose of the thesis and to be able to accept or reject the hypothesis of a unidirectional causality running from the stock market to the house market, a causality test is included. A well-recognized test, which has also been used in previous research, is the Granger causality test. The Granger causality test investigates the causal relationship. However, what actually causes what is a philosophical question. What Granger´s test of causality proves in this thesis is the predictive causality (Gujarati and Porter, 2009).

Two equations can be set up in order to demonstrate the Granger causality test:

$$Y_t = \sum_{i=1}^{n} \alpha_i X_{t-1} + \sum_{j=1}^{n} \beta_j Y_{t-j} + u_{1t} \quad (2)$$

$$X_t = \sum_{i=1}^{n} \gamma_i X_{t-1} + \sum_{j=1}^{n} \delta_j Y_{t-j} + u_{2t} \quad (3)$$

Where Y and X are the dependent variables. α, β, γ and δ are the estimated coefficients. The error terms, u, are assumed to be a white noise process with a zero mean, a constant variance and no serial correlation (Brooks, 2008). Equation 2 suggests that Y can be explained by its own past values and lagged values of X. Similar goes for Equation 3, X can be described by its own past values and lagged values of Y. Consider Equation 2, if the coefficients for lagged values of X, as a group, are statistically different from zero and the coefficients for lagged values of Y, as a group, in Equation 3 are not statistically different from zero, a unidirectional causality running from X to Y exist. In other words, X Granger causes Y if $\sum_{i=1}^{n} \alpha_i \neq 0$ and $\sum_{j=1}^{n} \delta_j = 0$. An unidirectional causality running from Y to X can be concluded if $\sum_{j=1}^{n} \delta_j \neq 0$ and $\sum_{i=1}^{n} \alpha_i = 0$. If the coefficients for lagged values of X and Y in both equations are statistically different from zero, as a group, a bilateral causality is indicated. On the other hand, independence can be concluded if the coefficients, as a group, are not statistically different from zero (Gujarati and Porter, 2009).

6.3.1 Assumptions

As most of the statistical tests, there are several assumptions that need to be satisfied for the results to be reliable. First, it is necessary for the time series to be stationary. This is an assumption of the standard F-test, which will be used to determine if the coefficients are statistically different from zero or not. A non-stationary process may cause a spurious regression, meaning that a statistical test may indicate two variables to have a significant statistical relationship even if their true relationship is non-existent (Brooks, 2008). A time series containing a unit root is a non-stationary process. Testing for a unit root is therefore a test of stationarity (Gujarati and Porter, 2009). The Augmented Dickey-Fuller (ADF) test and the Phillips-Perron test will be applied to evaluate whether the variables are stationary or not. A non-stationary variable can be transformed to a stationary process by taking the first difference.

The second assumption relates to the number of lags included in the model. The number of lags included can affect the direction of the causality. Including too many lags reduces the degrees of freedom which in turn decreases the explanatory power of the model. It may also cause multicollinearity. On the other hand, too few lags increases the chance of specification errors (Gujarati and Porter, 2009). It is therefore crucial to include the most optimal number of lags. The Akaike information criterion (AIC) will be applied to find the optimal number of lags to include in the model.

Third, structural breaks must be taken into consideration since it may disturb the relationship between the variables. A structural break means that the estimated parameters in the regression model are not constant for the whole sample period. If the relationship between the variables has changed, the causality test will give misleading results. Allowing for structural breaks reduces this problem (Gujarati and Porter, 2009). Structural breaks can occur from external forces or due to policy changes. Large changes in the interest rate or relaxed restrictions for borrowing are examples of policy changes that may induce a structural break in the house market. Booms and recessions in the general economy could also cause disturbances among the coefficients (Gujarati & Porter, 2009).

Lastly, this thesis is dedicated for determining the causality between house prices and the stock market. Thus effects influencing both markets should be removed from the study. Such effects were identified in section 4.3. It was concluded that interest rates and national income affect both markets, hence these two variables should be included as control variables in the statistical tests. If these variables/effects are not taken into consideration the Granger causality tests may indicate a deceptive causality between the two markets.

6.3.2 Vector Autoregressive Model

To account for the last assumption presented in section 6.3.1, the interest rate and the GDP are included in the statistical model as control variables. All four variables affect each other simultaneously and the statistical model needs to take this into account. It is therefore necessary to estimate a vector autoregressive model (VAR). The VAR model is a generalization of the autoregressive model, it can include more than one dependent variable. The final model that will be tested can be represented by equation 4 and 5 below.

$$\ln(S_t) = \sum_{i=1}^{n} \alpha_{1,i} \ln(S_{t-1}) + \sum_{i=1}^{n} \beta_{1,i} \ln(H_{t-1}) + \sum_{i=1}^{n} \gamma_{1,i} \ln(GDP_{t-1}) \sum_{i=1}^{n} \delta_{1,i} \ln(R_{t-1}) + u_{1t} \quad (4)$$

$$\ln(H_t) = \sum_{i=1}^{n} \alpha_{2,i} \ln(S_{t-1}) + \sum_{i=1}^{n} \beta_{2,i} \ln(H_{t-1}) + \sum_{i=1}^{n} \gamma_{2,i} \ln(GDP_{t-1} + \sum_{i=1}^{n} \delta_{2,i} \ln(R_{t-1}) + u_{2t} \quad (5)$$

Where S represents the S&P 500 index value, H is the S&P/Case-Shiller index value, GDP is the gross domestic product and finally, R represent the three month Treasury Bill. The error terms are assumed to be a white noise process. If the variables are co-integrated a vector error correction model (VECM) needs to be estimated. The VECM accounts for a potential co-integration among the variables. The Johansen test of co-integration will be applied in order to determine whether there exist any co-integration among the variables. The Granger causality test will be performed on the VAR/VECM model. For the test results to be reliable, the error terms in the statistical model are tested for serial correlation and heteroscedasticity.

6.4 Granger Causality: Stock Market and House Market

According to the second hypothesis the stock market causes the house market. To be able to accept or reject this unidirectional causality the Granger causality test is performed. Before testing the variables, they are all transformed by taking the natural logarithms. This transformation will reduce the chance of encounter heteroscedasticity. The transformation may also be a remedy for non-normally distributed variables. Moreover, using logs makes the interpretation of the impulse response function (IRF) more convenient.

The Granger causality test requires stationary variables and the first step is to investigate whether the S&P 500 and the S&P/Case-Shiller is stationary at level. The ADF test and the Phillips-Perron test of stationarity are applied. The null hypothesis states that the variable is non-stationary and the alternative hypothesis states that the variable is stationary. The two tests are performed with three different test equations. The first equation includes an intercept, the second includes a trend and an intercept and the final test equation includes neither a trend nor an intercept. To find the most appropriate test equation, the trend and the intercept are evaluated whether they are statistically significant. Once the optimal test equation is identified one can determine whether the variable is stationary or not. The results from the ADF test and the Phillips-Perron test are presented in table 6. Both variables are non-stationary at level. The variables are converted into first difference form and the tests are repeated. The results verifies that the S&P 500 and the S&P/Case-

Shiller are non-stationary at level and they become stationary after taking the first difference, hence they are integrated of the same order.

Table 6: Testing For Stationarity 1

Variable	**ADF**		**Phillips-Perron**		**Conclusion**
	Optimal test equation	P-value	Optimal test equation	P-value	
S&P 500	Neither a trend nor an intercept	0.9743	Neither a trend nor an intercept	0.9873	Non-stationary
S&P/Case-Shiller	Neither a trend nor an intercept[25]	0.9419	Neither a trend nor an intercept	0.9764	Non-stationary

The optimal number of lags to include in the model is determined by estimating a VAR model including logged values of the S&P 500 and the S&P/Case-Shiller in first difference. The maximum number of lags included in the lag selection procedure is set to eight quarters. A maximum of eight lags is justified from a theoretical perspective. The dependent variables should not be influenced by changes in the independent variables occurring more than two years earlier. Also, including a maximum of eight lags do not consume too many degrees of freedom. The optimal number of lags is determined by choosing the number of lags that minimizes the AIC. The optimal number of lags to include, according to the AIC, is seven. The variables are also tested for cointegration. The Johansen test of cointegration assumes that the variables are integrated of the same order, which was confirmed by the ADF test and the Phillips-Perron test. The test must be performed at level for each variable. Moreover, the test result is sensitive to the number of lags included, it is therefore crucial to include the correct number of lags for the results to be reliable. Running the test, including seven lags, indicates that there are no cointegration among the S&P 500 and the S&P/Case-Shiller, hence they have no long-run relationship. The P-

[25] Trend and intercept is significant at the 10 % level of significance

value for the Trace statistic is 0.2616 and the null hypothesis of no cointegration is therefore accepted hence an error correction equation is not included in the VAR model.

The estimated VAR model is tested for heteroscedasticity. White´s test of heteroscedasticity indicates that the model suffers from heteroscedasticity[26]. Hence the coefficients have no longer the lowest possible variance which implies that the standard errors are no longer efficient. This may affect the decision of rejecting or accepting a null hypothesis (Gujarati and Porter, 2009). The model is also tested for serial correlation by using the LM test. If the assumption of no serial correlation is violated the coefficients will no longer be efficient (Gujarati and Porter, 2009). The results indicate that the model does not suffer from serial correlation[27] (serial correlation exists for lag three only).

Equation 6 and 7 can be extracted from the VAR system. These two equations are presented below and the Granger causality test will be performed on these equations.

$$\begin{aligned}\ln(\Delta S_t) &= \alpha_{1,1}\ln(\Delta S_{t-1}) + \alpha_{1,2}\ln(\Delta S_{t-2}) + \alpha_{1,3}\ln(\Delta S_{t-3}) \\ &+ \alpha_{1,4}\ln(\Delta S_{t-4})\alpha_{1,5}\ln(\Delta S_{t-5}) + \alpha_{1,6}\ln(\Delta S_{t-6}) + \alpha_{1,7}\ln(\Delta S_{t-7}) \\ &+ \beta_{1,1}\ln(\Delta H_{t-1}) + \beta_{1,2}\ln(\Delta H_{t-2}) + \beta_{1,3}\ln(\Delta H_{t-3}) + \beta_{1,4}\ln(\Delta H_{t-4}) \\ &+ \beta_{1,5}\ln(\Delta H_{t-5}) + \beta_{1,6}\ln(\Delta H_{t-6}) + \beta_{1,7}\ln(\Delta H_{t-7}) + u_{1t}\end{aligned} \tag{6}$$

$$\begin{aligned}\ln(\Delta H_t) &= \alpha_{2,1}\ln(\Delta S_{t-1}) + \alpha_{2,2}\ln(\Delta S_{t-2}) + \alpha_{2,3}\ln(\Delta S_{t-3}) \\ &+ \alpha_{2,4}\ln(\Delta S_{t-4})\alpha_{2,5}\ln(\Delta S_{t-5}) + \alpha_{2,6}\ln(\Delta S_{t-6}) + \alpha_{2,7}\ln(\Delta S_{t-7}) \\ &+ \beta_{2,1}\ln(\Delta H_{t-1}) + \beta_{2,2}\ln(\Delta H_{t-2}) + \beta_{2,3}\ln(\Delta H_{t-3}) + \beta_{2,4}\ln(\Delta H_{t-4}) \\ &+ \beta_{2,5}\ln(\Delta H_{t-5}) + \beta_{2,6}\ln(\Delta H_{t-6}) + \beta_{2,7}\ln(\Delta H_{t-7}) + u_{2t}\end{aligned} \tag{7}$$

$$\begin{gathered}\Delta S\ is\ the\ first\ difference\ of\ the\ stock\ price\ index \\ \Delta H\ is\ the\ first\ difference\ of\ the\ house\ price\ index \\ u_1\ and\ u_2\ are\ the\ error\ terms\end{gathered}$$

The test hypothesis and results are presented in table 7. The result from the Granger causality test for the full sample period, including no control variables, indicates a *unidirectional causality running from the stock market to the house market.*

[26] For a full representation of the test see appendix
[27] For a full representation of the test see appendix

Table 7: Granger Causality Test of the Stock Market and the House Market

Null Hypothesis	Chi-Square	Probability	Conclusion
S&P/Case-Shiller do not Granger cause S&P 500	7.943213	0.3376	Accept
S&P 500 do not Granger cause S&P/Case-Shiller	36.87231	0.0000	Reject

This unidirectional causality is in line with the wealth effect. Implying that an appreciation of the stock market and/or the houses market causes an increase in the net wealth of a household and thus its consumption increases. The consumption of houses increases hence the demand and thus the price of houses increases as well. In the event of a depreciation of the stock market and/or the house market, the opposite is true. This finding is also in line with portfolio theory. According to the result, households tend to rebalance their portfolio as a consequence of changes in the value of the assets in the portfolio. This rebalancing affects house prices, but not stock prices. As expected, the credit-price effect is not present.

A unidirectional causality running from the stock market to the house market is also the main findings in previous studies. The direction of the causality seems to be the same regardless of time period, statistical methods or estimates used as inputs. Hence, the direction of the causality is the same for single family houses, REIT and other estimators of property prices. There are some exceptions to this, for example the study of McMillan (2012). He concluded a unidirectional causality running from the house market to the stock market in both the U.K and the U.S, the sample period was quite large (1974-2009). McMillan (2012) applied similar estimates of stock market movements and house price changes as this thesis does (S&P 500 and single family houses). However, the study applied an ESTR model which may explain the ambivalent results. Also the findings from the study conducted by Su et al. (2000) concluded this “opposite” causality for the U.K and the Netherlands. However, their sample period was shorter (2000-2007), hence the findings may be true during this specific period. The causality might be different in a longer time perspective. Moreover, the causality was not investigated in the U.S and differences across countries may exist.

The model suffers from heteroscedasticity and the results may therefore be unreliable. However the results are in line with both theories and empirical findings. Consequently, the presence of heteroscedasticity is not expected to influence the trustworthiness of the results. The hypothesis of a unidirectional causality running from the stock market to the house market is accepted.

6.5 Granger Causality Including Control Variables

This thesis is dedicated to investigating the relationship between the stock market and the house market. Previous section concluded that a unidirectional causality exists. However, the causality may exist due to common underlying fundamentals influencing both markets. To examining if this is the case, the Granger causality test is performed once again, now accounting for factors influencing both markets. Hence the interest rate and the GDP are included as control variables. Also here, all variables are transformed by taking the natural logarithms. The interest rate and the GDP are tested for Stationarity. The results from the tests are presented in table 8. It is conclude that both the interest rate and the GDP is non-stationary at level. The tests are repeated with the variables in first difference form. The results confirm that both variables are now stationary. Previous section concluded that the S&P 500 and the S&P/Case-Shiller is non-stationary at level but becomes stationary after taking the first difference. Hence all variables are integrated of the same order.

Table 8: Testing For Stationarity 2

Variable	**ADF**		**Phillips-Perron**		**Conclusion**
	Test equation	P-value	Test equation	P-value	
Interest rate	Trend and intercept	0.7858	Neither a trend nor an intercept[28]	0.4777	Non-stationary
GDP	Intercept	0.1290	Intercept	0.0630	Non-stationary

The optimal number of lags to include in the VAR model, with logged values of S&P 500, S&P/Case-Shiller, interest rate and GDP in first difference form, is seven according

[28] Trend is significant at the 10 % level

to the AIC. The variables are tested for cointegration and the Trace statistics from the Johansen test of cointegration indicates one cointegration among the variables. Hence a VECM with one error correction equation needs to be estimated to account for this long run relationship. White´s test of heteroscedasticity indicates that the null hypothesis of no heteroscedasticity is accepted[29]. The LM test of autocorrelation indicates that serial correlation exists at lag three, five and nine[30]. This small amount of autocorrelation is not expected to generate problems, hence the validity of the results should not be affected.

The Granger causality test is performed on the VECM. The hypothesis and the test results are presented in table 9 below. The Granger causality test indicates a *unidirectional causality running from the stock market to the house market.* The direction of the causality is not affected by the inclusion of control variables. It can therefore be concluded that the GDP and the interest rate do not provide further information of the causality between the two markets. The hypothesis of a unidirectional causality running from the stock market to the house market is accepted also when the control variables are included.

Table 9: Causality Test with Control Variables

Null Hypothesis	**Probability**	**Conclusion**
S&P/Case-Shiller do not Granger cause S&P 500	0.2649	Accept
S&P 500 do not Granger cause S&P/Case-Shiller	0.0000	Reject

6.6 Granger Causality Allowing for Structural Breaks

The results from previous sections indicate a constant unidirectional causality running from the stock market to the house market. However, the full sample period is large and it may include structural breaks which could produce deceptive test results. The direction of the causality may also be varying in different time periods. To investigate these issues, the full sample is divided into two subsamples. The full sample includes 107 quarterly observations, which is almost 27 years, and two economic recessions. The first subsample

[29] For a full representation of the test see appendix.
[30] For a full representation of the test see appendix.

reaches from 1987 to 2002. It includes 64 observations (16 years). The period is characterized by a slow and steady increase in both markets until 1995. The stock market increased rapidly after 1995 and it peaked in the year 2000. The S&P 500 decreases rapidly after year 2000. The house market on the other hand is characterized by a stable growth post 1995. The index did not decline during the dot-com bubble. The subsample is characterized by a relatively low volatility for both markets. The second period is smaller. It includes 43 observations (almost 11 years) from 2003 to 2013Q3. This period includes the most recent financial crisis in which both markets declined heavily. The second period is also more volatile compared to the first one. The Granger causality test in the subsamples will include the interest rate and the GDP as control variables.

6.6.1 Period 1: 1987-2002

The process of testing the direction of the causality in the subsamples is the same as in previous sections. The statistical tests suggest a VECM model with four lags[31], two cointegrations and all variables in logged, first difference form[32]. The VECM is tested for heteroscedasticity and serial correlation. The test results indicate that there are no heteroscedasticity or serial correlation present[33]. The Granger causality test is based on the estimated VECM model, the hypothesis and test results are presented in table 10 below. The Granger causality test indicates a *unidirectional causality running from the stock market to the house market*, which is consistent with the results in previous sections.

Table 10: Causality Test with Control Variables (Period 1)

Null hypothesis	Probability	Conclusion
S&P/Case-Shiller do not Granger cause S&P 500	0.5288	Accept
S&P 500 do not Granger cause S&P/Case-Shiller	0.0016	Reject

[31] The subsample includes fewer observations and to retain sufficient degrees of freedom the maximum number of lags included in the lag selection procedure is reduced to four. The AIC suggests four as the optimal number of lags to include.

[32] The ADF and Phillips-Perron test of stationarity indicate that the variables are non-stationary at level but stationary in first difference form.

[33] For a full representation of the tests see appendix.

This subsample includes one special event, the dot-com bubble, where the stock market declined heavily while house prices increased. This indicates a negative relationship. However, both markets increased prior to the dot-com bubble which indicates a positive relationship. Most likely, the correlation has been dynamic in this period, at least close to the dot-com bubble[34]. The causality on the other hand could have remained constant, but changes in the stock market could have had different impacts on the house market at different times. Also, the dot-com bubble is a small share of the subsample and events occurring prior to the bubble could have a larger influence on the direction of the causality. Hence the results indicate a unidirectional causality running from the stock market to the house market, even if a potential independence existed during the crisis.

6.6.2 Period 2: 2003-2013Q3

This period does also include a special event, the most recent financial crisis, where both the stock market and the house market decreased heavily. The recession originated from a bubble in the house market. Lenient lending standards combined with loose monetary policies boosted house prices. The financial crisis occurred when house prices started to decline and as a consequence of the crisis in the house market the stock market declined. Figures presented in previous sections indicate that the house market declined prior to the stock market. This subsample will investigate if the house market caused the stock market.

The statistical model estimated is similar to the one in the previous section. The VECM includes four lags[35], two cointegrations and all variables logged, in first difference form[36]. The model is tested for heteroscedasticity and serial correlation, it does not suffer from heteroscedasticity or serial correlation[37]. The Granger causality test is performed on the estimated model. The hypothesis and test results are presented in table 11 below. The Granger causality test indicates a *unidirectional causality running from the stock market to the house market*.

[34] This statement is based on the figures plotted in section 2 (Background) investigating historical movements in the two markets.

[35] Also here, the maximum number of lags in the lag selection procedure is set to four. According to the AIC, the optimal number of lags to include is four.

[36] The ADF and Phillips-Perron test of stationarity indicates that the variables are non-stationary at level but becomes stationary in first difference form.

[37] For a full representation of the tests see appendix.

Table 11: Causality Test with Control Variables (Period 2)

Null hypothesis	Probability	Conclusion
S&P/Case-Shiller do not Granger cause S&P 500	0.6582	Accept
S&P 500 do not Granger cause S&P/Case-Shiller	0.0056	Reject

The results are surprisingly the same as previous sections and studies. The two statistical models in both subsamples are similar, they both include two cointegrations and a lag of four quarters. Theories and investigations of the most recent financial crisis have concluded that the decrease in the house market was the beginning of the crisis, which is also in line with the graphical analysis in section 2. The Granger causality investigates the predictive causality and what actually causes what is more of a philosophical question. The results indicated that the stock market Granger caused the house market from 2003 to 2013Q3. It is possible that a unidirectional causality running from the house market to the stock market existed close to the crisis. The direction of the causality could potentially be sensitive to unique economic events. Most likely, the causality is dynamic in the short run but the unidirectional causality running from the stock market to the house market exists in the long-run. The unidirectional causality running from the stock market to the house market may have a greater influence on the overall direction of the causality in the long-run compared to the unidirectional causality running from the house market to the stock market.

6.7 Impulse Response Function

The Granger causality test provides information regarding the direction of a potential causality among the variables. The test investigates if lagged values of a variable have a statistical impact on the future values of the other variables. The test does not provide information about the size or timing of the influence on the other variables. The Impulse Response Function (IRF) is a complement to the Granger causality test. It provides information on the size and timing of the causality, and thus fits the purpose of this thesis. The estimation of the IRF is necessary in order to answer the third hypothesis. It investigates how the VAR system responds to shocks in the error terms. A shock to an error term in one of the equations in the VAR system does affect all other equations in the system as well. This method reveals information on how long time it takes for these shocks to fade away, that is how long time it takes before the shocks have no longer any impact on the VAR model. If the shocks progressively fade away, the system is said to be stable. The IRF does also reveal if the relationship among the variables is positive or negative (Brooks, 2008).

The IRF presented in this section is based on the model developed in section 6.5. The model includes seven lags of S&P 500, S&P/Case-Shiller, interest rates and GDP. All variables are logged and then converted into first difference. The Johansen test of cointegration discovered one cointegration, hence a VECM model was estimated. It was concluded that the model does not suffer from heteroscedasticity or serial correlation. A unidirectional causality running from the stock market to the house market was concluded. The IRF of the S&P/Case-Shiller due to a shock in the S&P 500 is presented in figure 4. The figure depicts how the S&P/Case-Shiller reacts to a one unit positive shock in the stock market at t=0. The X-axis illustrates the time (in quarters) while the Y-axis displays the percentage change in house prices. The interpretation of the graph is: A one unit increase in stock prices causes a 0.02 % raise in house prices in period four.

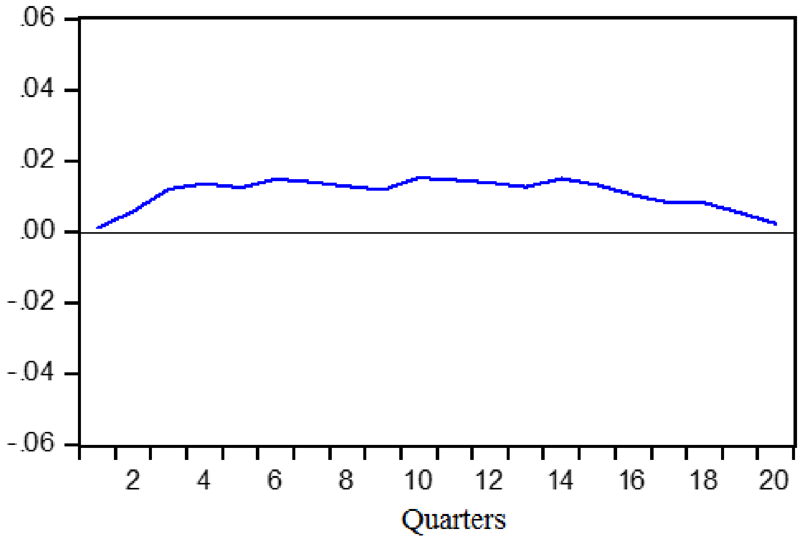

Figure 4: Impulse Response Function for House Market

A shock in the stock market influences the house market immediately. Almost maximum effect is attained after three periods. The effect on the house market fluctuates around this value until period 14 after which it gradually fades away. The maximum effect is attained in period 10 and amounts to a 0.015279 percentage influence on house prices. The influence is positive from t=0 to t=20. The shock almost disappears after period 20, indicating that the system is stable. The *accumulated* IRF is depicted in figure 5. The figure indicates that the S&P/Case-Shiller increases by 0.032581 percentage one year after a one unit positive shock to the S&P 500. The same number amounts to 0.142282 and 0.217496 percentage three and five years after the shock respectively. The accumulated IRF seems to be almost linear until period 20.

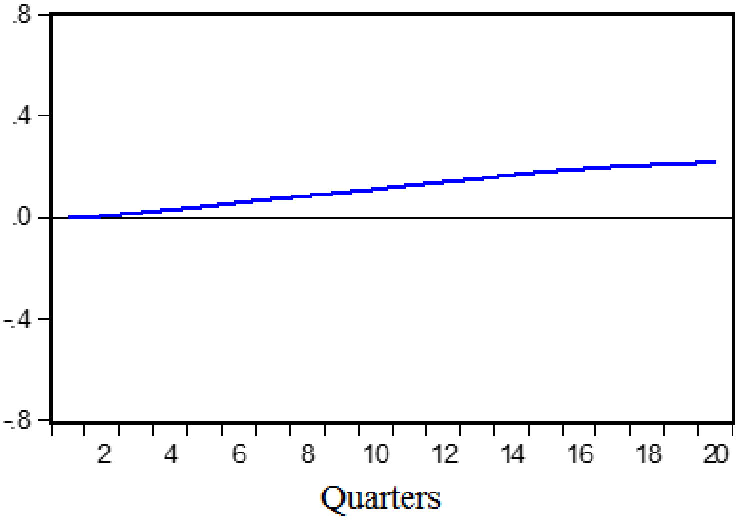

Figure 5: Accumulated Impulse Response Function for House Market

The Granger causality test concluded a unidirectional causality running from the stock market to the house market and the bivariate correlation matrix concluded that the two markets have a positive relationship. The IRF supports these findings. The results from the IRF indicate a time lag of three quarters before the shock reaches almost maximum effect. The time lag may arise due to the heterogeneous characteristic of houses. It could be time consuming to find a new house to purchase. Moreover, it takes time for a household to adjust their consumption of houses.

The elasticity of house prices due to a shock in the stock market in the U.S was found to be approximately 14 % after three years. The results are fairly similar to the findings of Sutton (2002). He concluded that a 10 % increase in the stock market causes a 1 % increase in house prices, which corresponds to an elasticity of 10 %. The study of Sutton was conducted from 1995 to 2002 and the larger elasticity found in this thesis could be interpreted as an increase in the wealth effect and the needs of rebalancing the portfolio. Moreover, the significance of stocks and houses of the accumulated wealth could have increased hence households are more sensitive to changes in the two markets. Also, changes in the stock market and the house market may have been perceived as unanticipated and permanent to a larger extent compared to the sample in 1995 to 2002.

The elasticity after one year was estimated to 3.25 %, also here Sutton´s results are similar. He estimated an elasticity of 3 %. The elasticity is fairly low one year after the shock (compared to the elasticity after three and five years). The lower elasticity could be explained by the nature of the supply side of houses. It takes time to construct new houses and the short run supply is therefore relatively fixed, hence house prices are not sensitivity to changes in demand in the short run. The responsiveness to changes in house prices increases once new houses have been constructed. Also, households may interpret changes in the stock market as temporarily in the short run and the consumption is therefore not fully adjusted, as projected by the permanent income hypothesis.

The elasticity after three years found in this thesis (14 %) is in the middle of the results from other countries investigated. Kakes and Van Den End (2004) found an elasticity of 25 % in the Netherlands three years after a shock to equity prices. Sutton (2002) concluded an elasticity of 10 % for Canada and Ireland. The same number amounted to 20% in the Netherlands and Australia. The elasticity was found to be 50% in the U.K. The different results may arise due to differences in the impact of the wealth effect and the different needs of rebalancing the portfolio. Other potential explanations could be found in the different ownership rates of stocks and houses across countries. Moreover, differences in the share of stocks and houses of the total accumulated wealth across countries could influence the results. The elasticity should be higher in countries where stocks and houses are extensively possessed, this because changes in the two markets influences wealth to a larger extent.

The third hypothesis is accepted. The full effect is attained after 2.5 years (10 quarters) and the elasticity of house prices due to a shock in the stock market is 14 %.

6.8 Practical Implications

The bivariate correlation analysis concluded that a large and positive correlation exist between the stock market and the house market, hence there are only minor diversification benefits realized from investing in both types of assets. As presented in section 2, almost 45% of the wealth of American households consists of stocks and houses, hence households are highly exposed to changes in the two markets. A unidirectional causality running from the stock market to the house market was concluded and the impulse response function indicated that a one unit change in the stock market causes a 0.032581 percentage change in house prices one year later. A one unit decrease in stock prices reduces the value of real estates possessed by American households by 7.04 billion of dollars[38] one year after the shock to the stock market. The same number amounts to 30.75[39] and 47.00[40] billion of dollars after three and five years respectively. This is the consequences from a one unit change in the stock market, a permanent 20 % drop in stock prices would have devastated ramifications. The wealth of households would deteriorate and their consumption as well, which in turn affects the health of the general economy. A hedging instrument, limiting the risk and its consequences, is needed. Such an instrument would reduce fluctuations in wealth and financial recessions would be less painful.

Being conscious about the relationship and the nature of the causality should improve the decision making process of policymakers. By understanding the consequences of a change in the stock market, policymakers are able to implement policies limiting the ramifications before the full effect is reached. Moreover, the findings are important for banks and other institutes reviewing mortgage applications. A drop in the stock markets causes falling house prices, hence the creditworthiness of a household deteriorates. They are now aware of that changes in the stock markets affects the creditworthiness immediately and almost maximum effect is reached after three quarters. The results are also valuable for households not owning a house today but plan to be an owner in the future and for households planning to sell their house. By planning the purchase/sale of the house it is feasible to realize the highest possible value from the transaction.

[38] (21610.9*(1-0.0003258))-21610.9=-7.0410473
[39] (21610.9*(1-0.00142282))-21610.9=-30.74842074
[40] (21610.9*(1-0.00217496))-21610.9=-47.00284306

7 Conclusion

This thesis has investigated the relationship between the stock market and the house market in the U.S. The topic is important to highlight since stocks and houses are large components of the wealth of American households. A relationship could have a significant influence on the health of the general economy. The wealth effect and the modern portfolio theory proposes a unidirectional causality running from the stock market to the house market. The credit-price effect suggests the opposite direction.

Quarterly data of the S&P 500 and the S&P/Case-Shiller from 1987Q1 to 2013Q3 was the estimates of stock market and house market movements. The bivariate correlation matrix analysis concluded that a positive and significant correlation exists between the two markets hence the hypothesis of a positive relationship was accepted. The Granger causality test, based on a vector autoregressive model, indicated a unidirectional causality running from the stock market to the house market. The GDP and the interest rate were also included as control variables but the direction of the causality did not change. To investigate a potential dynamic causality, the full sample was divided into two periods (1987-2002 and 2003-2013Q3), both subsamples indicated a unidirectional causality running from the stock market to the house market. Previous research conducted in different countries, time periods and with different measurements of price changes came to the same conclusion. Theories reviewed do also indicate that the stock market causes the house market. Hence the hypothesis of a unidirectional causality running from the stock market to the house market is accepted. However, the direction of the causality may be dynamic during shorter periods of times and further research should investigate the issue during booms or recessions, the sample should not include both. The causality is constant in the long run and do also exist for single family houses and not only for real estates which may include (except for single family houses) shopping malls, office buildings and warehouses etc.

To investigate the timing and the size of the causality, an impulse response function was estimated. It was concluded that the effect from changes in the stock market arrives immediately and reaches almost full effect after 3 quarters. A one percentage change in stock prices causes an accumulated change in house prices of 0.0326 percentage after one year, the same number amounts to 0.1423 and 0.2175 percentage after three and five years respectively. Which corresponds to a change in the value of real estates possessed by

American households by 7.04, 30.75 and 47.00 billion of dollars after one, three and five years respectively. The findings imply that a permanent and unanticipated change in the stock market has a significant effect on wealth of American households, hence a hedging instrument limiting the consequences from changes in the stock market should be developed. The findings are also valuable for policymakers and investors planning to buy/sell a house in the future.

7.1 Suggestion for Further Research and Improvements

This study investigated the causality on a national level. The study does not provide information of potential regional differences within a country. Regional differences influencing the causality could arise due to an uneven distribution of wealth or local policies affecting both markets (local tax policies for example). The same direction of the causality may not be present in a region where stocks and/or houses are only a small share of the total wealth. If regional differences exist, general national policies influencing both the stock market and the house market might not be the best decision for the entire nation. Hence the causality should be investigated in different regions within a country.

The GDP and the short term interest rate were included in the statistical model as control variables. There are numerous other factors influencing the two markets (expectation of future house prices and stock prices, unexpected inflation, expected inflation etc.). Including other control variables could potentially influence the causality, however the unidirectional causality running from the stock market to the house market has been concluded previously and the results are also in line with theories reviewed. The inclusion of other control variables could affect the impulse response function though. It would be interesting to investigate if there exist any potential differences due to the choice of control variables.

This study has also investigated the causality in two periods with different characteristics and the direction of the causality was found to be the same in both periods. To investigate the direction of the causality further the sample period should only include booms or recessions, not both. However, booms and recessions often occur during a shorter period of time and it may be difficult to find enough observations to acquire reliable statistical results.

More research should be devoted to investigating the size and impact of the causality. The size and timing of the causality are important to comprehend in order to be able to understand and encounter the consequences. An increased number of studies, conducted at different times and in different countries, with different methodologies will increase the understanding. This is closely related to the development of a hedging instrument limiting the consequences from changes in the stock market. A thorough understanding is necessary in order to develop a well-operating hedging instrument.

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Appendix

White´s Test of Heteroscedasticity for the VAR Model With no Control Variables

Chi-square	Probability	Conclusion
141.8393	0.0001	heteroscedasticity

LM Test of Serial Correlation for the VAR Model With no Control Variables

Lags	LM-statistic	Probability
1	4.0510	0.3991
2	1.4368	0.8378
3	**9.5233**	**0.0493**
4	6.5054	0.1645
5	3.7265	0.0443
6	0.8441	0.9324
7	3.5956	0.4635
8	5.4014	0.2485
9	8.7282	0.0683
10	2.0979	0.7177
11	4.8818	0.2996
12	1.7689	0.7782

White´s Test of Heteroscedasticity for the VAR Model Including Control Variables

Chi-square	Probability	Conclusion
636.4949	0.0518	homoscedasticity

LM Test of Serial Correlation for the VAR Model Including Control Variables

Lags	LM-statistic	Probability
1	14.2462	0.5804
2	20.4131	0.2022
3	**29.3036**	**0.00220**
4	16.1946	0.4395
5	**39.6606**	**0.0009**
6	13.7142	0.6200
7	9.5912	0.8871
8	23.2354	0.1076
9	**39.0060**	**0.0011**
10	14.5889	0.5549
11	16.9872	0.3864
12	22.1205	0.1393

White´s Test of Heteroscedasticity for the VAR Model Including Control Variables (subsample 1)

Chi-square	Probability	Conclusion
373.6634	0.2989	homoscedasticity

LM Test of Serial Correlation for the VAR Model Including Control Variables (subsample 1)

Lags	LM-statistic	Probability
1	6.5575	0.9809
2	22.1336	0.1389
3	17.5333	0.3519
4	12.5626	0.7044
5	20.3121	0.2065
6	10.6840	0.8286
7	14.6597	0.5497
8	22.7259	0.1213
9	17.7190	0.3406
10	8.6643	0.9266
11	19.1904	0.2589
12	6.7166	0.9783

White´s Test of Heteroscedasticity for the VAR Model Including Control Variables (subsample 2)

Chi-square	Probability	Conclusion
371.9853	0.3204	homoscedasticity

LM Test of Serial Correlation for the VAR Model Including Control Variables (subsample 2)

Lags	LM-statistic	Probability
1	4.7039	0.9970
2	8.4569	0.9341
3	8.0073	0.9486
4	12.6122	0.7009
5	12.2440	0.7270
6	11.1946	0.7973
7	26.0551	0.0533
8	24.5870	0.0774
9	19.7135	0.2334
10	9.9698	0.8682
11	17.0587	0.3818
12	15.5548	0.4844

Impulse Response Function of House Market to a Shock in Stock Market

Response of S&P/Case-Shiller				
Period	GDP	Interest Rates	**S&P 500**	S&P/Case-Shiller
1	0.002142	0.000265	**0.001108**	0.009354
2	0.000777	-0.000698	**0.005847**	0.015276
3	-0.002475	-0.004914	**0.011930**	0.017228
4	-0.004889	-0.006657	**0.013695**	0.019811
5	-0.003463	-0.010898	**0.012388**	0.029050
6	-0.003896	-0.015691	**0.014871**	0.034365
7	-0.004130	-0.023745	**0.014081**	0.034520
8	-0.004045	-0.027922	**0.012828**	0.034256
9	-0.002291	-0.032486	**0.011798**	0.040675
10	-0.005136	-0.037772	**0.015279**	0.043147
11	-0.007617	-0.043386	**0.014697**	0.041533
12	-0.009186	-0.044152	**0.013758**	0.041370
13	-0.009819	-0.044119	**0.012722**	0.047139
14	-0.014798	-0.044354	**0.015052**	0.050128
15	-0.019300	-0.044979	**0.013216**	0.048447
16	-0.021830	-0.042446	**0.010436**	0.048613
17	-0.022912	-0.041219	**0.008085**	0.054052
18	-0.026676	-0.041558	**0.008151**	0.056907
19	-0.029160	-0.043012	**0.005303**	0.054881
20	-0.029214	-0.042222	**0.002250**	0.053858

Accumulated Impulse Response Function of House Market to a Shock in Stock Market

Accumulated Response of S&P/Case-Shiller				
Period	GDP	Interest Rates	**S&P 500**	S&P/Case-Shiller
1	0.002142	0.000265	**0.001108**	0.009354
2	0.002919	-0.000433	**0.006956**	0.024629
3	0.000444	-0.005347	**0.018886**	0.041857
4	-0.004445	-0.012004	**0.032581**	0.061668
5	-0.007908	-0.022902	**0.044969**	0.090717
6	-0.011804	-0.038593	**0.059840**	0.125082
7	-0.015933	-0.062338	**0.073921**	0.159602
8	-0.019978	-0.090260	**0.086749**	0.193857
9	-0.022269	-0.122746	**0.098547**	0.234533
10	-0.027405	-0.160518	**0.113826**	0.277680
11	-0.035022	-0.203904	**0.128524**	0.319213
12	-0.044208	-0.248055	**0.142282**	0.360582
13	-0.054027	-0.292174	**0.155004**	0.407721
14	-0.068825	-0.336528	**0.170055**	0.457849
15	-0.088126	-0.381506	**0.183271**	0.506296
16	-0.109955	-0.423953	**0.193707**	0.554909
17	-0.132867	-0.465171	**0.201792**	0.608961
18	-0.159543	-0.506729	**0.209943**	0.665868
19	-0.188703	-0.549741	**0.215246**	0.720749
20	-0.217917	-0.591963	**0.217496**	0.774607