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Asymmetric Wealth Effect in the U.S and European Markets: Threshold Cointegration Approach

Pedro Manuel da Silva Coelho

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Asymmetric Wealth Effect in U.S. and European Markets: Threshold Cointegration Approach

Pedro Manuel da Silva Coelho

Dissertação de Mestrado

apresentada ao Instituto Superior de Contabilidade e Administração do Porto para a obtenção do grau de Mestre em Contabilidade e Finanças, sob orientação do professor Luís Miguel Pereira Gomes e a professora Patrícia Alexandra Gregório Ramos

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Dedicatória

Gostaria de dedicar este meu percurso académico (e todas as conquistas inerentes) aos meus avós por todas as adversidades que ultrapassaram, com distinção, ao longo das suas vidas mostrando-me assim que com trabalho e perseverança tudo é possível.

Agradecimentos

Gostaria de deixar o meu agradecimento a algumas pessoas que desempenharam, de uma forma ou de outra, um importante papel em mais uma marcante etapa do meu percurso académico que chega agora ao fim.

Em primeiro lugar agradeço ao professor Luís Gomes e à professora Patrícia Ramos por toda a disponibilidade, dedicação, conhecimento transmitido e ajuda enquanto orientadores da minha dissertação de mestrado.

Agradeço aos meus pais, ao meu irmão e à Conceição todo o apoio e paciência ao longo de todo o meu percurso académico.

Agradeço a uma pessoa que foi o meu pilar durante este percurso, que me apoiou sempre que era necessário e tinha uma palavra de carinho e amor para comigo. A uma pessoa que tem um valor incalculável e imprescindível para mim. Obrigado, Inês.

Durante o meu percurso encontrei pessoas que me ajudaram imenso e, por essa razão, deixo uma palavra de gratidão para com a Sofia Rebelo, a Andreia Ferreira, a Carla Cachinho e ao Jorge Maia.

Por fim, não poderia deixar de realçar o excelente apoio que a Mariana Lourenço, a Andreia Testa, a Mariana Guimarães, a Mariana Prata e ao José Moutinho me deram durante os meus 25 anos de vida.

Resumo:

Este estudo visa em verificar as relações de ajustamento existentes entre mercados acionistas e mercado imobiliário e segue o estudo realizado por Chiang, Lee, & Tsai (2012). São estudados quer o mercado acionista norte americano – este representado pelo Standard and Poors' 500, Dow Jones Industrial Average e Freddie Mac House Price Index- como também o europeu – representado pelo Financial TSE 100 e Euro STOXX 50. A metodologia aplicada quebra face à maior parte dos estudos previamente feitos, onde eram aplicados modelos lineares. A utilização desses modelos pode retornar resultados falaciosos pois os ajustamentos dos mercados são diferentes quando ocorrem choques negativos e positivos. Como tal foi utilizado o modelo TAR e MTAR de modo a testar as duas hipóteses formuladas sendo elas: (1) o equilíbrio a longo prazo dos mercados; (2) a verificação de existência de ajustamentos assimétricos. Os resultados recolhidos apontam para a existência de cointegração entre eles, na maior parte dos casos.

Palavras chave: TAR, MTAR, cointegração, mercados.

Abstract:

This study aims to verify the equilibrium relationships among various markets – housing market and stock market – in a long-run and follows the study of Chiang, Lee, & Tsai (2012). The markets that are studied are the North American stock market and Housing market and European stock market. The North American stock market is represented by Santadard & Poors' 500 and Dow Jones Industrial Average, and the housing market is represented by Freddie Mac House Price Index. The European stock market is represented by Financial Times Stock Exchange 100 and Euro STOXX 50. The methodology applied does not follow most of the studies due to the fact that those studies used a linear framework. The results obtained from that models can lead to misinformation of the reality since the adjustments made from the series differ if the shock is either negative or positive. For that reason, the study applies the TAR and MTAR models to test both hypotheses. The first is the long-run equilibrium in the markets and the second is to verify if the adjustments are asymmetric. The results point out to the existence of cointegration for the majority of the indexes.

Key words: TAR, MTAR, cointegration, markets.

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Abbreviations

APT - Arbitrage Pricing Theory

CAPM - Capital Asset Pricing Model

DJIA – Dow Jones Industrial Average (North American index)

Freddie - Freddie Mac House Price (North American index)

FTSE – Financial Time Stock Exchange 100 index (European Index)

MTAR - Momentum Threshold Autoregression model

Q1 – Quarter 1

Q3 – Quarter 3

SPX - Standard & Poor's 500 (North American index)

STOXX – Euro STOXX 50 index (European Index)

TAR - Threshold Autoregression model

U.K. – United Kingdom

U.S. – United States of America

VAR - Vector autoregressive

INTRODUCTION

Ever since the end of the 20th century, financial markets have been increasing the flow of money due to the growth of number of participants, the number of financial instruments and the freedom of capital markets.

In a competitive world, investment decisions determine the success, or the failure, of most portfolio managers, fund managers, governments, companies, and every individual that have the goal to return their investments alongside with interests.

Investment decisions have been increasing the know-how and programming skills due to the nonstop improvement of technology (artificial intelligence) and their use in financial markets. Thorough the years, financial transactions have been increasing rapidly thus, investment decisions can be executed promptly.

Investor and portfolio managers have been using models like Capital Asset Pricing Model (CAPM) and Arbitrage Pricing Theory (APT) to improve the returns of the portfolio whilst reducing its risk. However, should evidence of arbitrage theory be proven both models are undermined.

The market transfers wealth from one hand to another therefore, the knowledge on how the market moves and reacts have been getting attention by the agents. By understanding those movements, a portfolio manager can implement a strategy on their clients' portfolios to improve their gaining for a certain risk. Notwithstanding, the markets could be considered irrational as a result of the reaction of the players. For instance, the Dotcom Bubble and post-Covid market are a perfect example on how irrationality of the players can lead to overpriced markets.

Diversification is a weapon that portfolio managers hold to reduce the losses during market crashes and can be achieved by either spreading the budget over many assets or acquiring less risky assets such as U.S. treasury bonds. Nevertheless, diversification does not guarantee full protection against political and macroeconomic events as well as the behaviour of the investors (Huang et al. 2005). Not only managers seek for diversification, but also individual investors have been trying to protect their portfolios using a combination between stock market and housing market.

International diversification started to gather attention after the study of Grubel (1968). Managers have been seeking for markets with imperfect correlations. However, according to Srivstava (2007), the correlation between emerging markets have been increasing.

Moreover, the diversification through international investment could lead to a financial crisis such as in East Asia and Mexico, in the 90s, drove by the influence of exchange rate and withdrawals of investments.

Regarding housing market, the portfolios are constructed accordingly to the investor's wealth thus, the diversification it is not as effective as the portfolios of stocks. Moreover, the housing market is affected by the irrationality of the investors as well (Case and Shiller, 1989; Shiller, 1993, 2005). Such irrationality comes from the perspective of the investors to different scenarios.

In both portfolios, monetary policies affect the value of the assets however, the housing market reacts slower than stock market to shocks (Case and Shiller, 1989; Shiller, 1993, 2005; Tsai, 2015). Moreover, according to Leamer (2007) and Mishkin (2004), the housing market is influenced on purpose by monetary policies. In terms of business cycle, some authors defend that the stock market has greater explanatory power than the housing market. However, from the latest recessions, 8 out of 10 had a significant decrease in the housing construction.

The housing market and stock market are connected between them by two mechanisms through which is transferred cash flow. The first is the value added to housing market whenever the returns on stock market is increased (wealth effect). The second one is the credit-price effect on which the growth of real estate leads to an increase in stock market. These effects have been studied through the year by many authors.

The purpose of this research is to investigate possible correlations between housing and financial markets. Multiple studies have been looking for cointegrated markets across the world. In this case, the study covers the United States of America (U.S.) and European markets. To do so, it was computed the Threshold Autoregression model (TAR) as well Momentum Threshold Autoregression model (MTAR) combining the following indexes: Dow Jones Industrial Average (DJIA), Standard & Poor's 500 (SPX), Freddie Mac House Price (Freddie), Euro STOXX 50 (STOXX) and Financial Times Stock Exchange 100 (FTSE).

Cointegration was first studied by Granger (1981) however, only after the crash of the markets in 1987 the investors and portfolios managers became more aware of cointegration (Kanas, 1998). Cointegration is defined as the probability of two nonstationary time series follow the same direction in the long-term. Moreover, the exhibit of cointegration could lead to a shift in the construction of portfolios to make it possible to mitigate the risk (Mackinnon, 1991).

There are various tests for cointegration between series, the vector autoregressive (VAR) and TAR are two examples. VAR was presented by Sims (1980) and Litterman (1986). TAR was studied by Tong (1978) and it is not commonly used due to the difficulty to estimate threshold values.

For almost half of a century, the number of studies of cointegration between markets have been increasing which resulted in many authors finding evidence of cointegration and later being refuted. That problem was referenced by Svristava (2007), that defended that different methods would obtain different results such as Blume and Friend (1973) who found segmentation between bond market and stock market and Roll (1977) that disproved their concept. Haremi (2008) used a different approach – included two structural breaks in the model - on studying the integration between U.K. and U.S. markets and concluded there is a steady relationship between them.

Developed markets were the first to be studied such as U.S., Japan, and European markets. According to the literature reviewed, various number of papers examine the U.S. markets against another. Regarding the tests comparing U.S. market and European ones, Kanas (1998) did not find evidence of cointegration between these markets. Nonetheless, Arshanapali and Doukas (1993) indicated a bivariate cointegration between both markets, disproving Taylor and Tonks (1989) that found bivariate cointegration between UK and U.S. markets.

Concerning the influence of the U.S. market in Asian markets, Arshanapalli et al. (1995), Ghosh, Saidi and Johnson (1999), Siklos and Ng (2001) conclude that the integration may have started either after the market crash in 1987 or after the Gulf war. There is evidence that Asian markets presented cointegration thorough the 90s, according to Manning (2002). Kim (2005) affirmed the impact is greater in the Asian markets rather the Japanese. Moreover, the U.S. market presents more impact on global returns in Nikkei index (Cheung and NG, 1992). Some Asian markets presented integration with U.S. markets, however, more recent data tend to achieve greater integration (Srivastava, 2007).

Not all the cointegration tests are between stock markets, Liu et al (1990) realized a test between the stock market and housing market and concluded the property shares are integrated with the US stock market. Such a disparity on the results of the cointegration found in tests of the stock markets, have also been found in the tests between housing market and stock market. Recent studies conclude the markets are cointegrated due to the adjustment of the error-correction model and the cointegration approach.

1 Financial Markets

In the late 20th century, financial transactions experienced exponential growth due to the freedom of capital markets, numerous and diverse financial instruments, and an increase in economic flows both in developed and developing countries, thus increasing the number of transactions on a daily basis.

Comparison between assets is commonly done through the measurement of their return and risk. Sharpe (1964) developed the Capital Asset Pricing Model (CAPM) and Lintner (1965) attribute the price in order to the Beta or economic risk. Ross (1976) develop the Arbitrage Pricing Theory (ATP) by setting the characteristics of the risks and their identification. Both models will be undermined in case of arbitrage theory might exist.

The international investment (portfolio diversification) has impact on macroeconomic policies. These investments can influence exchange rates (i.e. appreciation/depreciation) which, therefore, trade and fiscal imbalances between countries. In the 1990s, East Asia and Mexico faced a financial crisis due to the sudden withdrawals of the investments.

The financial markets can be influenced with both political and economic events which can be observed, for example, in unemployment rate (Boyd et al., 2005) and manufacturing production indexes (Nasseh and Strauss, 2000).

The Dotcom Bubble (late 90s to early 2000) is one extraordinary example on how human perception of the event (for instance an optimistic view) will dictate/influence market reaction. That hype led a grow of nearly 3500 points (1500 to 5000) on NASDAQ from 1997 to 2000. Quantitative Easing is a monetary policy where a central bank acquires government bonds. Thus, the injection of liquidity in the economies implies a reduction on deflation (Joyce et al. 2012), is a good example of a policy affecting market conditions applied by US Federal Reserve, Bank of England and European Central Bank. Interest rates are lowered due to emerging money supply which leads to higher levels of liquidity (lending). Low rates imply cheaper costs of capital, thus the investment and the consumer spending will increase the valuation of the companies as well. Moreover, the returns of the risk-free assets will decrease leading to investment in the capital markets (higher demand for equity on which brings up the value of the stocks).

2 Diversification

The big question for an investor, either an institution or an individual, is “How can I have a portfolio protected against market volatility?”. An investor must have an appropriate investment decision regarding asset allocation for his portfolio in order to obtain the best return according to desired risk.

International diversification allows investors to buy securities across countries in order to increase average returns whilst reduce portfolio risk. Investors use this investment approach however, there is an assumption that must be achieved. According to Jorion (1985), variables such as “classical mean-variance analysis” should be known.

The formula of the variance of any portfolio equal investment in N securities was given by Markowitz.

$$\sigma_p^2 = \sum_{i=1}^{N} \left(\frac{1}{N}\right)^2 \sigma_i^2 + \sum_{i=1}^{N}\sum_{j=1}^{N} \left(\frac{1}{N}\right)^2 \mathrm{Cov}(i,j)$$

Elton and Gruber (1977) use the Markowtiz formula but using the expected value of the variance as the dependent variable.

$$E(\sigma^2) = \frac{1}{N}\overline{\sigma^2} + \overline{\mathrm{cov}(\imath,\jmath)} - \frac{1}{N}\overline{\mathrm{cov}(\imath,\jmath)}$$

Where,

- $E(\sigma^2)$ is the expected variance of the portfolio;
- σ^2 is the average variance of all stocks in the portfolio;
- $\mathrm{cov}(i,j)$ being the covariance of the stocks of the portfolio.

We can infer that the expected variance presents a negative correlation either with the number of securities hold and their covariance.

A well-diversified portfolio does not guarantee any drawdown, as the financial markets can be influenced by multiple variables (political, macroeconomics...) as well as by investors’ expectations. (Huang et al. 2005). Chen (2009) also refers to investors’ expectation and macroeconomic events as variables with impact on the movement of the stock market, thus the real investment opportunities may deviate from trend (Flannery & Protopapadakis 2002).

Ever since the study of Grubel (1968), correlations between capital market have been widely studied due to the benefits of a portfolio diversified through various markets. Market correlations have impact on portfolios diversification once diversification theories assume that there is no correlation between market prices. International fund managers and researchers have been seeking for international correlations in order to improve the portfolios' diversification. These correlations include mainly two implications: the diversification and macroeconomic progress of the involved countries (Srivstava, 2007). The international portfolio diversification happens as a result of an imperfect correlation between various national markets. However, studies had proved this type of diversification has been decreasing due to the globalization and the increasing correlation between the emerging markets (Srivstava, 2007). Policymakers and investors could use causal relationships between real estate market and stock market in order to predict market performances (Case, Quigley, and Shiller 2005; Chen 2001; Kapopoulos and Siokis 2005).

The household's portfolios are diversified, mainly, by two types of assets - stock market and real estate - the growth of economy and family's financial condition is upon movements in those markets (Li et al.,2015 and Tsai, 2015). Thus, diversification of the household's portfolios especially relies on linkages between these two markets. Both markets are affected by general economic activities, e.g., whenever stocks investors' wealth are raised by a positive shock, housing may increase their value because investors have more money to spend. The study of the correlation between those two markets is important and essential for the investors in the stock market (Chiang, Lee, & Tsai,2012). Henry Lowenfeld (1909) developed one strategy of international diversification and concluded that, in order to obtain greater performance, the investors should spread the capital in equal proportion, over several geographical areas.

3 Housing Market and Stock Market

Country developments are commonly determined by house pricing and stock indices (Lou, 2016). The second half of the 20th century presented a rise of returns both on capital markets as well as in real estate. For the unleveraged real estate, a general index had an annual compound rate of approximately 8.3%. However, the investors held the leverage real estate which led to greater returns.

Real estate is hold by two types of investor- the investor with higher taxes, holds leverage real estate due to the tax shield (real estate has a negative effect on tax rate), and the investor that tries to obtain tax benefits and control (Ibbotson and Siegel, 1984). Real estate equity is similar to stocks, it is likely that in price is included economic risk as well as inflation and residual risk. As real estate portfolio is almost dependent on the investor's wealth, the diversification is not very large, which increases the residual risk (Ibbotson and Siegel, 1984). Due to irrational behaviour, housing market is not efficient (Case and Shiller, 1989; Shiller, 1993, 2005). This hypothesis has been studied after the housing market bubble burst in the U.S. Shiller (2009) refers excessive subsidy policy as one of the inappropriate government interventions. Genesove and Mayer (2001) study the trades made in real estate market in Boston during the 1990s and confirmed the "disposition effect" once sellers were not able to recognize capital losses. Moreover, during the rough market conditions sellers choose not to sell their assets. Thus, if the government intervenes without considering the irrational behaviour, policies may be invalid and cause severe fluctuations (Tsai, 2013).

According to Sousa (2010) and Guo and Huang (2010) prices of stock market and real estate are influenced by monetary policies. However, Adams and Fuss (2010) refer value of real estate is primarily affected by economic activity. Despite the two markets are likely to perform similarly when facing the same event, real estate markets present a slower response due to market efficiency (Case and Shiller, 1989; Shiller, 1993, 2005; Tsai, 2015). Notwithstanding, studies point out the crisis of 2007 which was led by excessive subsidy policies (Shiller, 2009) and easing monetary policy (McDonald and Stokes, 2013).

Considering the relationship between house pricing and business cycle, Leamer (2007) and Mishkin (2004) refer the use of the monetary policies from the countries in order to influence housing market. Taylor (2007) examines the policies of the Federal Reserve during the first decade of 2000 and conclude the monetary policies aid the bubble of house pricing. Dufrénot and Malik (2010) study the relationship among business cycle and house pricing and conclude the growth of house pricing could be used as an indicator for turning point in U.S., U.K. and Spain. Moore (1983), Siegel (1991) and Chauvet (1998-1999) study the stock market as an indicator of business cycle. Over the 41 recessions since 1802, 38 had a loss in the stock market at least 8-percent (Siegel, 1991). On the other hand, Leamer (2007) says the housing market is a greater indicator for business cycle. From the latest recessions, 8 out of 10 had a significant decrease in the housing construction.

The volatility from the housing market and the stock market differs when shocks occur. When a shock is negative, the stock market is more volatile, on the other hand when it is positive both present similar volatilities. Therefore, in a down market, markets may not present a relationship, notwithstanding a positive correlation (indicator of cointegration in a rising market). Schwert (1989) presents negative shocks are higher than the positives (2.5 times greater), in the US. The real estate market and the stock market's relationship may differ according to the period. The wealth effect between these two markets can be observed during a normal period, however during a crisis the relationship might be strengthened due to the risk of transactions (Tsai, 2015). Green (2002) refers the wealth effect between the stock market and the real estate market in the US occurs whenever the housing prices are high. Nontheless, Li and Wang (1995), Okunev and Wilson (1997), Okunev, Wilson, and Zurbruegg (2002), and Tsai, Lee, and Chiang (2012) refer the correlation between those markets and the possibility of structural breaks. The first-time abnormal volatility was documented in the stock market was during the great depression in the 1930s (Officer, 1973). Ever since, studies found the volatility is asymmetric (the shocks tend to have more impact on a down trend market) in the U.S. stock market (Chiang, Lee, & Tsai ,2012). Black (1976) affirms that due to leverage, the movements are greater in a down market and it is proved by Schwert (1989). The impact of the leverage can be computed using the model created by Figlewski and Wang (2000).

There are two transmission mechanisms between stock market and housing market. First is the "wealth effect" which implies an increase of the return in the stock market will lead a higher housing consumption and price. Second is the "credit-price effect" on which implies an increase on the stock market whenever there is a growth in the price of real estate market (Granger, 2015). Su (2011) studies the credit-price effect and wealth effect using a non-linear causality test, and concludes that credit-price effect appeared in Germany, Netherland and U.K. Moreover, wealth effect was documented in Belgium and Italy. Both effects were felt in France, Spain and Switzerland. Chiang, Lee, & Tsai (2012) use a standard linear Granger causality test in the context of TEC model and conclude that in the U.S., the wealth effect is greater when stock market has higher returns than housing market. McMillan (2012), applies an exponential smooth transition (ESTR) in the non-linear causality test and finds evidence of credit-price effect in U.S. and U.K. Kapopoulos and Siokis (2005) were able to support the wealth effect in Athens. Bouchouicha (2013) suggests the credit-price effect in the U.S and U.K. is greater than wealth effect. Aye et al. (2013) not only conclude there is cointegration between the stock market and the real estate market, but also that there is a bi-directional causality between those two assets prices.

4 Cointegration

Cointegration verifies the long-term equilibrium of two variables. Despite the fact the variables may deviate in the short-term, the market forces will unit them in the long-term. Cointegration became more appealing to investors since the market crash in October 1987, which led to a similar trend along stock prices (Kanas, 1998).

Granger (1981) defines cointegration as the possibility of two nonstationary variables moving together. Cointegration might have strong implication on the construction of international portfolios in order to diversify risk (Mackinnon, 1991). Liu et al (1990) define integration as the risk that prices both in the house market and the stock market are provided by the systematic risk of the overall market index. On the other hand, segmentation occurs when the risk is related to the commercial real estate market. Granger et al. (2015) define integration as movement' replica between markets, whereas segmentation do not follow that condition (what occurs in one market it is not guaranteed to occur in the other). The segmentation/integration of the markets will improve the performance of the forecasts by the policymakers (Chen, 2001; Case et al., 2005; Kapopoulos and Siokis, 2005).

Engle and Granger (1987) develop the definition and prove that cointegration series present an error representation. Engle and Granger (1987) recommend diverse techniques for testing if two or more series are not cointegrated (null hypothesis). These techniques are approximated to a few tests presented by Fuller (1976) and Dickey and Fuller (1979).

Both tests do not follow any tabulated distribution. Engle and Granger (1987), Engle and Yoo (1987) and Phillips and Ouliaris (1990) had bring new tables for the Engle and Granger test, however, they were proved to be inaccurate. Furthermore, the critical values are only available for a “few finite samples size” and the asymptotic critical values provided are not the important ones (MacKinnon, 2019)

The vector autoregressions (VAR) model was first studied by Sims (1980) and Litterman (1986). Engle and Yoo (1987) study the predictions using the cointegration model proposed by Granger (1981), Granger and Weiss (1983) and Engle and Granger (1987). The authors said the VAR is inappropriate to forecast for the economic time series that they use, because the model suffers misspecification making the forecasts deviate from each other. The VAR model does not consider the misspecification. However, they consider the VAR as a convenient model to forecast and estimate systems of economic time series. Engle and Granger (1987) develop the model proposed by Granger (1983) which adds the moving average and error correction.

However, time series do not always follow a linear behaviour thus, the study of models such as bilinear, exponential autoregressive and threshold autoregressive (TAR) have been increasing. Moreover, nonlinear models likewise TAR and momentum threshold autoregressive (MTAR) have been studied due to their uniqueness. Nonetheless, TAR model has not been applied with frequency due to the threshold variable and the estimating associated threshold variable being difficult to identify. Tong (1978) was the first to study this model, and it was later expanded by Tong and Lim (1980) and Tong (1983). A TAR model is used as a linear proxy to a general non-linear model and its regime is verified by the value of ztd, where d is the delay parameter. This parameter allows to determine the timing of the adjustment process that is necessary more than one period in order to be able to the switch of the regime occurs. MTAR (like TAR) is a model on which captures the deepness asymmetry in the data. However, if zt is considered a stationary series, the test for that deepness in TAR model similar as test of skewness in zt.

4.1 Cointegration in Financial Markets

Blume and Friend (1973) provide evidence of segmentation between bond market and stock market. Whereas Roll (1977) affirms that these results only occur because they use a poor market proxy. In addition, to prove the existence of segmentation is required a strong proxy. Stehle (1997), computed the first empirical test to segmentation and integration of the US stock market and global market, not being able to reject the null hypothesis. The methodology was based on the traditional model of Fama-MacBeth (1973).

Jean and Von-Furstenberg (1990) use the VAR approach and conclude that the co-movement of stock markets have increased since the crash. Conversely, Koop (1994) uses Bayesian methods, and the results indicate that there were no common trends. The initial studies for integration were conducted for developed markets such as US, Europe and Japan (which had left recently a crisis) and the authors would reach opposite results due to the methodology chosen (Svristava, 2007).

4.1.1 Europe

Hatemi (2008), studies the possibility of the U.K. and U.S. financial markets are integrated. The author does not follow the conventional cointegration tests (tests between time series only computed for one regime shit), he added three residual-based test statistics in order to consider two possible regime shits. He was able to identify two structural breaks (one in 1991 and other in 1992; the Gulf War and exchange rate crisis in Europe might be the reasons for those breaks) and appears to exist a long and steady relation between these two markets. Perron (1989) proves that unit roots have a low power of explanation whenever a structural break happens and is not considered. In the same study, the author uses unit roots that recognize one structural break at a given time. Subsequently, many studies were made in order to develop models that included various structural breaks (Zivot and Andrews 1992; Perron 1989; Bai and Perron 1998, 2003). Regarding the cointegration tests, Greogory and Hansen (1996) show that in the presence of a regime shift that is not considered, the unit roots have low power of explanation.

Kanas (1998) tests the pairwise cointegration between U.S. stock market and European equity markets (U.K., Germany, France, Switzerland, Italy and Netherlands) in the period between 03/01/83 and 29/11/96. The author uses the Johansen method and the Bierens nonparametric approach and find no cointegration between these two markets.

Arshanapali and Doukas (1993) study interdependencies between U.K., Germay, France and US and the results indicated a bivariate cointegration between both European markets as well as between U.S. market and European markets. On the other hand, Taylor and Tonks (1989) don´t find evidence of a bivariate cointegration between U.K. and U.S. markets.

Longin and Solnik (1995) use GARCH (1,1) model in order to study the correlation of monthly excess returns in the period between 1960 and 1990 for different seven countries (Germany, France, UK, Japan, Sweden, Canada, U.S.). The authors conclude that the covariance and correlation matrices over that period are not constant. Whenever conditional volatility is high, results suggest greater correlation between the countries. The results are aligned with Koch and Koch (1991), which concluded the markets had grown more interdependency. The study of Von Fursyenberg and Jeon (1989) uses a VAR approach and reaches similar results. Alternatively, Kaplanis (1998) and Ratner (1992) conclude that international correlations would keep constant.

Lou (2016) studies the "nonlinear causality between the real estate and stock returns" on south European countries (Portugal, Italy, Greece and Spain). The author finds evidence of nonlinear causality relationship between these countries especially in the tail quantile.

Wilson and Okunev (1999) also study integration/segmentation of securitized real estate and stock market over the long run for U.S., U.K. and Australia. The authors reach the conclusion that in the U.S. and U.K. there was evidence for segmentation. Regarding Australia, the authors find evidence of some integration. Okunev et al. (2000) use a causality test on the relationship between securitized real estate and stock market and conclude there is solid unidirectional causality.

4.1.2 Asia

Kim (2005) discovers that U.S. market has a greater influence in Asian markets rather than the Japanese. Asian crisis had a strong impact on the short-term connections between the Asian markets (Lim and Yang, 2002). Hence, after the crisis, connections became to increase between those markets. On the other hand, the authors exclude any relationship on the long-term and the Japanese market has no influence on the integration neither in pre-crisis scenario nor after. Svirastava (2007) studies the possible integration between eight Asian markets and the U.S. markets during September 1997 and June 2006. The results suggest that the integration differs from period to period and the last years of the sample have greater values for integration. Ong (1995) is not able to find evidence of correlations between the Singaporean markets and real estate market.

Cheung and NG (1992) study the dynamic properties of stock returns in Tokyo and New York (January 1985 – December 1989) and are able to conclude that U.S. market has more impact on global returns.

Byers and Peel (1993) and Kasa (1992) use a multivariate cointegration model between three European markets and US, Japan, and Canada, reaching different conclusions. Lean (2012) studies the dynamic correlations between house price, stock price and interest rates in Malaysia and finds mixed evidence on credit-price and wealth effects.

Arshanapalli et al. (1995), Ghosh, Saidi and Johnson (1999), Siklos and Ng (2001) demonstrate the influence of U.S. market in the Asia-Pacific markets. The integration between these markets is believed to have started after the market crash (1987) or the Gulf War (1991). Besides the U.S. market influence also Japanese markets had an impact on Asia-Pacific market. Nevertheless, neither Japan nor U.S. had exclusively influence the Asia markets (Srivstava 2007). Choudhry and Lin (2004), Ghosh et al. (1999), Phylaktis and Ravazzolo (2002) detect cointegrations between Asian markets both with U.S. and Japan markets. Manning (2002) finds cointegration between Asian indexes (Hong Kong, Indonesia, Japan…) through the 90s.

Sim and Chang (2006) study the stock market and real estate market in South Korea on which was not found reverse causation. Ding, Chong and Park (2014), study nonlinear causal relationship between Chinese stock market and house pricing and their results show evidence of casual relationship both in the upper and lower quantile.

Liow (2006) follows an autoregressive distributed lag (ARDL) and conclude that in Singapore, the stock market is integrated with residential and office property".

4.1.3 U.S.

Lee and Kim (1994) follow Cheung and NG (1992) and study the effect of the crash (1987) and conclude that markets became more interrelated and that whenever U.S. stock market has bigger volatility the co-movements between countries are stronger.

Okunev, Wilson and Zurbruegg (2000) study the dynamic relationship between these two markets in the U.S. from 1972 to 1988. They use both a linear and nonlinear causality methods to determine whether there is a relationship between DJIA and house market. The results are spurious, as they present a “strong unidirectional relationship” between these markets.

4.2 Cointegration in Housing Market

Cointegration between housing and stock market has been studied throughout the years. Liu et al (1990) were the first to study the integration between house pricing market and stock market. The authors follow the methodology of Jorion and Schwart (1986) and find that property shares are integrated with stock market. Furthermore, there is evidence that real estate market is segmented from the stock market. The authors find evidence that segmentation is mainly due to indirect barriers (cost, amount and quality of information). Nevertheless, Ambrose et al. (1992) use fractional cointegration tests created by Okunev and Wilson (1997) and reach opposite conclusions, moreover, their results indicate possibility of integration between stock market and securitized real estate market.

Ibbotson and Siegel (1984) and Worzala and Vandell (1993) state that U.S. stock market and housing market are neither highly correlated nor negatively correlated. The VAR model is used by Sim and Chang (2006) and they are not able to find evidence of wealth effect in Korean markets. Quan and Titman (1997) find there is no relationship between stock and housing markets in the U.S. On the other hand, Green (2002) reveals the wealth effect between housing market in California and stock market from 1989 to 1998. Tsai (2015) studies the evaluation of the dynamic information between stock market and housing market, on which concludes that there is no long-term relationship however, there is evidence of short-term causal relationship.

Liu et al (1990) and Okunev and Wilson (1997) can’t find connections between real estate and stock market. More recent studies adjusted the model (“error-correction modelling and cointegration approaches”) and are capable of concluding that markets are cointegrated (Liow and Yang, 2005; Liow, 2006; Liu and Su, 2010; Tsai, Lee, and Chiang ,2012; Ding, Chong, and Park, 2014; Lin and Fuerst, 2014; and Bahmani-Oskooee and Wu, 2017). However, Bahmani-Oskooee and Ghodsi (2018) call into question previous studies results because the authors only used data from one specific country. Bahmani-Oskooee and Ghodsi (2018) use indexes for each state and obtain greater results supporting the presence of wealth effect “at the state level in the short-run relative to the long-run”.

Chiang, Lee, & Tsai (2012) study the long-run equilibrium between stock market and house pricing. Their results suggest the existence of cointegration between these markets, however “the adjustments made for the long run are asymmetric”. The authors also stress that mixed results obtained from previous studies were due to the linear econometric models. The variables (both macroeconomic and financial) react on a non-linearly form. Prices from both stocks and real state are affected by the economic activities, therefore it is expected that the markets exhibit a nonlinear reaction. Hence, the linear models were incorrectly used.

Chang et al. (2015) use a wavelet approach in order to study the relationship between housing market and stock market from 1890 to 2012. The authors conclude the “co-movement and causality vary across frequencies and evolve over time”. The authors affirm that the studies made to conclude relationships between the stock and housing market “falls into three main braches of inquiry”. The first objection is due to the tests used throughout the studies. Xiao-Lin et al. (2015) also examine the relationship between U.S. market and house market using a wavelet analysis over the period from 1890 to 2012. The authors find the two markets present casual effects in the long term. Researchers used linear and non-linear tests in order to determine if the markets are integrated or segmented (Ambrose et al., 1992; Wilson and Okunev, 1999; Liow, 2006; Lin and Fuerst, 2012; Liow and Yang, 2005; Chiang, Lee, & Tsai, 2012). Second, the authors used the “Granger causality tests in vector autoregressive (VAR), vector error-correction (VEC), and threshold error-correction (TEC) models” in order to obtain the linkages between those markets (Gyourko and Keim, 1992; Okunev et al., 2000; Sim and Chang, 2006; Su, 2011; Su et al., 2011; McMillan, 2012; Shirvani et al., 2012; Chiang, Lee, & Tsai, 2012). The last objection is over the correlation tests used in the beginnings (Ibbotson and Siegel, 1984; Hartzell, 1986; Eichholtz and Hartzell, 1996; Worzala and Vandell, 1993; Quan and Titman, 1999). Despite the fact that correlation can demonstrate co-movement between variables, it does not reach the same conclusions for long-run and lead-lag relationships. The markets from US, UK, and Canada were studied by Ibbotson and Siegel (1984), Hartzell (1986), and Eichholtz and Hartzell (1996). All studies show a negative correlation between these markets. However, Worzala and Vandell (1993) reach a positive correlation in the UK. Moreover, Quan and Titman (1999) also reach to a positive correlation between those two markets (real estate and stocks) for seventeen countries.

Based on the literature previous described, and since this study updates the data from Chiang, Lee, & Tsai (2012) the hypotheses are:
"H1: There exists a long-run equilibrium relationship between the housing and the stock market markets, but adjustments from disequilibrium errors are asymmetric.
H2: The wealth effect between the two markets is more obvious when the stock price performance is better than the housing price performance. Otherwise, the wealth effect does not exist."

5 Data

The main purpose of this study is to explore the hypothesis of cointegration in the U.S. and in Europe. The data was extracted from the Refinitiv Database. The indexes from the U.S. are the Freddie, DJIA and SPX. Regarding the European indexes, were extracted the FTSE, and STOXX.

Chiang, Lee, & Tsai (2012) reported a correlation between the house market (Freddie Mac) and stock market (Dow Jones Composite Average). The first step is to update the time series (1989: quarter 1 (Q1) to 2020: quarter (Q3)) in order to test the hypothesis that this correlation continues to exist in more recent years. Afterwards, this study will verify if there are signs of cointegration between DJIA and Freddie. Finally, those tests will be computed between American and European stock markets.

The indexes can be categorized as in table 1:

	Stock Market	Real Estate
U.S.	DJIA SPX	Freddie
Europe	FTSE STOXX	-

Table 1 – Indexes.

To compute the statistical analyses, it was used the software R due to its functionalities and wide variety of statistical techniques. The package used was the “atp”, which was created to compute threshold cointegration analyses as well as asymmetric correction model (Sun, 2011). All indexes were transformed into natural logarithms. The sample contains data from 1981: Q1 to 2020: Q3.

6 Methodology

The relationship between price variables has been studied through cointegration models such as Johansen test and Engle-Granger two steps approach. Balke and Fomby (1997) extended the original approach of Engle and Granger (1987) proposing a two-step approach. Enders and Granger (1998) and Enders and Siklos (2001) used a generalized Dickey-Fuller test that includes the possibility of "asymmetric movements in time-series data" (Sun, 2011) allowing to dismiss the hypothesis of "symmetric adjustment to a long-term equilibrium" (Sun, 2011). Thus, this type of models have been used in research regarding asymmetric price transmissions such as the stock market indexes (Shen et al.,2007) and prices of swiss pork (Abdulai, 2002). Therefore, this study follows the same type of modelling to examine: (1) the price dynamics in the stock market and the house market in the U.S.; (2) the dynamics between the stock market in the USA and Europe.

6.1 Linear cointegration analysis

To examine the nonstationary hypothesis, it was used the Augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1979) in order to verify the nonstationary and the order of integration of the variables. A cointegration analysis is applicable if both series appear to have a unit root.
Considering that Engle-Granger two-step approach is one of the most used cointegration test (Enders, 2004), it was used for the purpose of this study.

Engle-Granger two step approach is focused "on the time series property of the residuals from the long-term equilibrium relationship" (Sun, 2011):

$$(1)\ \ U_t = \alpha_0 + \alpha_1 W_t + \varepsilon_t$$

$$(2)\ \ \Delta\hat{\varepsilon}_t = \rho\hat{\varepsilon}_{t-1} + \sum_{i=1}^{P} \varphi_i \Delta\hat{\varepsilon}_{t-i} + \mu_t$$

Where α_0, α_1, ρ and φ_i are coefficients; $\varepsilon_t$is the error term and $\hat{\varepsilon}_t$ are the estimated residuals which are used in the unit root test on a second stage (Engle and Granger, 1987). The Δ is the first difference and μ_t represents a white noise term. *P* is the number of lags, being selected according to an Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC) or Ljung-Box Q test.

The residual series is considered stationary if the null hypothesis ($\rho = 0$) is rejected and consequently means that both variables are cointegrated. The value of the lags is chosen in order to prevent serial correlation in the residual's regression.

6.2 Threshold cointegration analysis

In order to establish asymmetric adjustments as an inherent part of cointegration analysis, Enders and Sikko (2001) considered a two-regime threshold cointegration. The model adapts equation 2 to:

$$(3)\ \Delta\hat{\varepsilon}_t = \rho_1 I_t \hat{\varepsilon}_{t-1} + \rho_2(1 - I_t)\hat{\varepsilon}_{t-1} + \sum_{i=1}^{P} \varphi_i \Delta\hat{\varepsilon}_{t-i} + \mu_t$$

$$(3a)\ I_t = 1\ if\ \hat{\varepsilon}_{t-1} \geq \tau, 0\ otherwise; or$$

$$(3b)\ I_t = 1\ if\ \Delta\hat{\varepsilon}_{t-1} \geq \tau, 0\ otherwise$$

Where *P* is the number of lags, as previous, calculated according to AIC, BIC or Ljung-Box Q test. ρ_1, ρ_2 and φ_i are coefficients, τ is the threshold value and I_t is the Heaviside indicator. The indicator I_t can be based on two definitions of τ , either using the lagged residual ($\hat{\varepsilon}_{t-1}$) or the change of that lag ($\Delta\hat{\varepsilon}_{t-1}$). The first two formulas (3) and (3a) represent a Threshold Autoregression (TAR) model, on the other hand equation (3) and (3b) represent a Momentum Threshold Autoregression (MTAR) model. Whilst TAR model is able to collect "potential asymmetric deep movements in the residuals" (Sun, 2011), MTAR is designed to consider "steep variations in the residuals" (Sun, 2011) and it is used especially when it is believed there is an adjustment however there is more momentum from one side than the other. Whenever there is a negative deepness (|p1|≤|p2|) of residuals, increases tend to recur, while decreases cause a recover to the equilibrium much sudden (Enders and Granger, 1998).

The threshold value can be assumed to be zero. Chan (1993) uses a method to obtain a consistent estimate of these value. The first step is to sort the threshold variable in ascending order for TAR or MTAR. Secondly, determine the threshold values. In case those values are not meaningful, “the threshold variable must actually cross the threshold value” (Sun, 2011). In order to ensure an acceptable number of observations from both sides, it is excluded the top 15% and the last 15% of the values sorted in the first step. To conclude the process, it is needed to estimate TAR and MTAR models by computing the sum of squared errors and examine the relationship with the threshold values. The consistent value is the threshold value that minimizes the sum of squared errors.

This study includes four models: TAR (τ = 0), consistent TAR (τ estimated), MTAR (τ = 0) and consistent MTAR (τ estimated). To select the best model to continue the study, and accordingly to Enders and Siklos (2001), it was calculated AIC and BIC values and the model that presented the lowest values was chosen. As far as cointegration tests is concerned, two tests were computed: (1) F test to examine cointegration, being the null hypothesis (H_0: $\rho_1 = \rho_2 = 0$) under test that there is no evidence of cointegration against the alternative of cointegration with adjustments (TAR and MTAR); (2) Standard F test, to examine the symmetric adjustments in the long-term equilibrium, being H_0: $\rho_1 = \rho_2$. If H_0 is rejected, then there is evidence of asymmetric adjustment process.

6.3 Asymmetric error correction model with threshold cointegration

Engle and Granger (1987) defend that it is possible to estimate an error correction model when all the variables are cointegrated. Moreover, accordingly Sun (2011), the “adjustment process due to disequilibrium among the variables is symmetric”.

There are two extensions for analysing the asymmetric price transmissions developed by Granger and Lee (1989) and Balke and Fomby (1997) and Enders and Granger (1998). Granger and Lee (1989) stated that both of the first differences on the variables and the error correction can be broken down as either negative or positive components. This extension provides information on the asymmetric effects that can be caused by these differences on the dynamic behaviour of the indexes. Regarding the second extension, Balke and Fomby (1997) and Enders and Granger (1998) declared whenever there is validation of the presence of the threshold cointegration, “error correction terms are modified further” (Sun, 2011):

$$(4a)\ \Delta W_t = \theta_w + \delta_W^+ E_{t-1}^+ + \delta_W^- E_{t-1}^- + \sum_{j=1}^{J} \alpha_{Wj}^+ \Delta W_{t-j}^+ + \sum_{j=1}^{J} \alpha_{Wj}^- \Delta W_{t-j}^- + \sum_{j=1}^{J} \beta_{Wj}^+ \Delta U_{t-j}^+ + \sum_{j=1}^{J} \beta_{Wj}^- \Delta U_{t-j}^- + \vartheta_{Wt}$$

$$(4b)\ \Delta U_t = \theta_U + \delta_U^+ E_{t-1}^+ + \delta_U^- E_{t-1}^- + \sum_{j=1}^{J} \alpha_{Uj}^+ \Delta U_{t-j}^+ + \sum_{j=1}^{J} \alpha_{Uj}^- \Delta U_{t-j}^- + \sum_{j=1}^{J} \beta_{Uj}^+ \Delta W_{t-j}^+ + \sum_{j=1}^{J} \beta_{Uj}^- \Delta W_{t-j}^- + \vartheta_{Ut}$$

The values of ΔW_t represent the first difference of the U.S. indexes and ΔU_t represent the first difference of the European, Θ, δ and α are coefficients and ϑ is the error term. Time is represented by t, the subscripts values of W and U differentiate the coefficients of the indexes and *j* represents lags. The first difference of the lags could be either positive or negative, thus it is represented by the subscripts + and – in *W* and *U. J* is the maximum lag, and it is chosen by AIC, BIC and Ljung-Box Q test to the residuals have no serial correlation. Regarding the error correction term, E_t, it is computed from the threshold cointegration (equations 3, 3a and 3b).

Interpretation of the estimated coefficients can lead to various results such as the presence of asymmetric price behaviour and display “the response of individual variables to the disequilibrium in the previous periods” (Sun, 2011).

6.4 KPSS

The KPSS was presented by Kwiatkowski et al. (1992) and mitigates the power of explanation by the unit roots. The test is based on the LM test and follows three steps. First, it extracts the OLS residuals of an estimation regression between Y_t over a constant and computes the sums of all values of t ($S_t = \sum_{s=1}^{t} \hat{e}_s$). Second, it is calculated the test statistics KPSS = $\mathrm{T}^{-2} \sum_{\mathrm{t}=1}^{\mathrm{T}} \frac{\mathrm{S}_{\mathrm{t}}^2}{\widehat{\vartheta^2}}$, being $\widehat{\vartheta^2}$ an estimation for the variance in the long term. Lastly, it is compared to the critical value (c) against the KPSS. If KPSS > c, then the null hypothesis (H_0: Y_t stationary) is rejected and the alternative (H_1: Y_t presents unit roots) is accepted. The critical values are 0.74, 0.47 and 0.35 for 1%, 5% and 10% significance level, respectively.

7 Results

The Table 2 reports the descriptive statistics of the indexes from March 1989 to September 2020 (127 observations). The index that presented a highest value was the DJIA (28 538), as expected, whilst the lowest value was from Freddie's (0.225). On average, the DJIA (11 245) presents values eight times greater than SPX (1 287.6). Regarding the European indexes, the FTSE (5 090) demonstrates greater values than the STOXX (2 570.7), on average. Regarding the housing market index, the values are substantially lower than the stock market indexes. Regarding the skewness, all the North American indexes show positive values, in contrast to the European ones that have negative values. To conclude the descriptive statistics, only the DJIA and SPX exhibit positive values regarding the kurtosis. The logarithm of the indexes as well as their returns are presented in the Figures 1 and 2, respectively.

	Freddie	DJIA	SPX	STOXX	FTSE
Mean	23,624	11 245,00	1 287,60	2 570,70	5 090,00
Std. Dev.	25,348	6 581,62	736,254	986,2479	1 580,65
Minimum	0,225	2 294,00	294,9	807,7	1 990,00
Maximum	72,99	28 538,00	3 363,00	5 059,10	7 688,00
Skewness	0,6555	0,7817	0,8175	-0,073	-0,3929

Table 2 - Descriptive Statistics

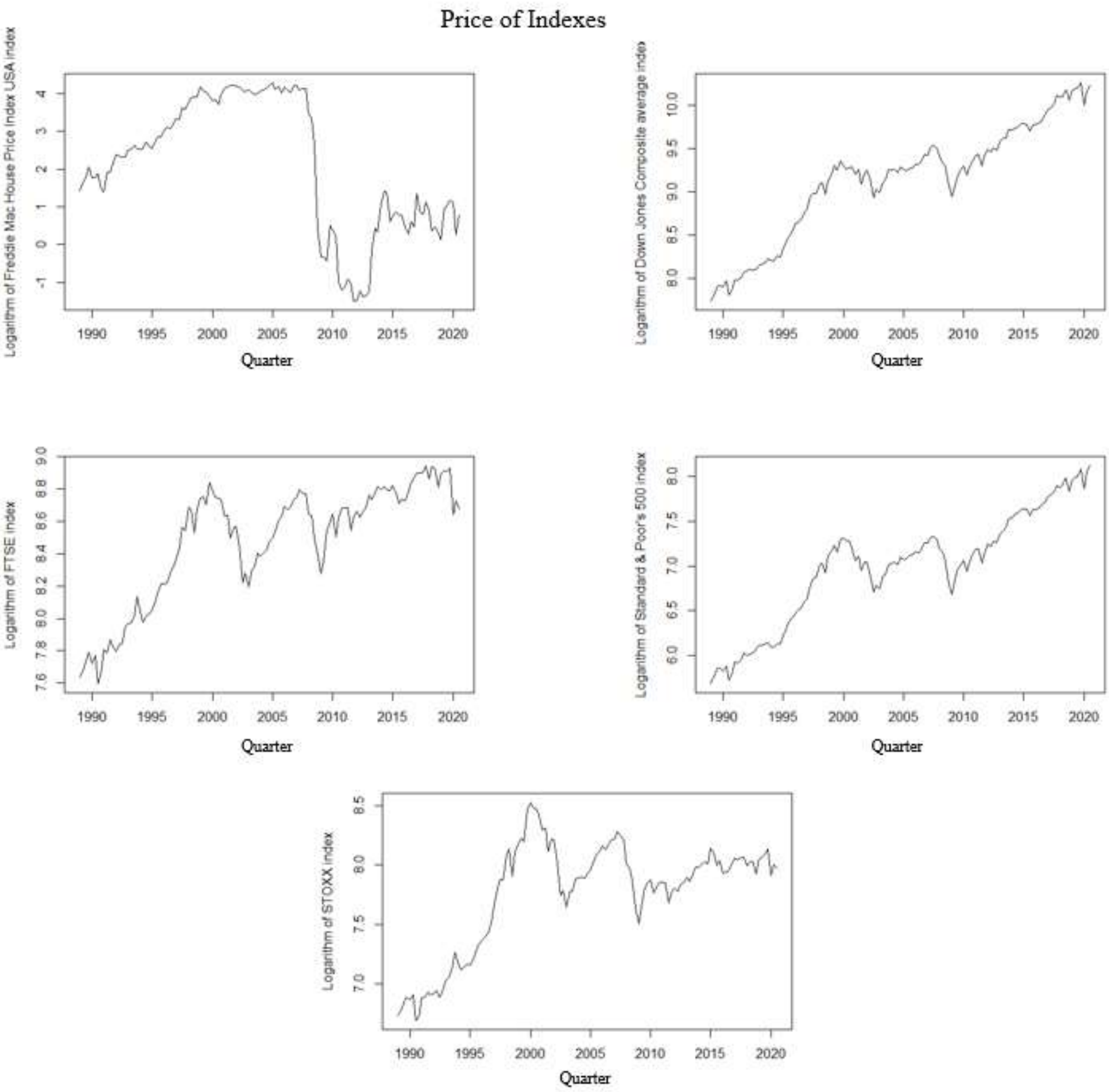

Figure 1 – Prices of indexes.

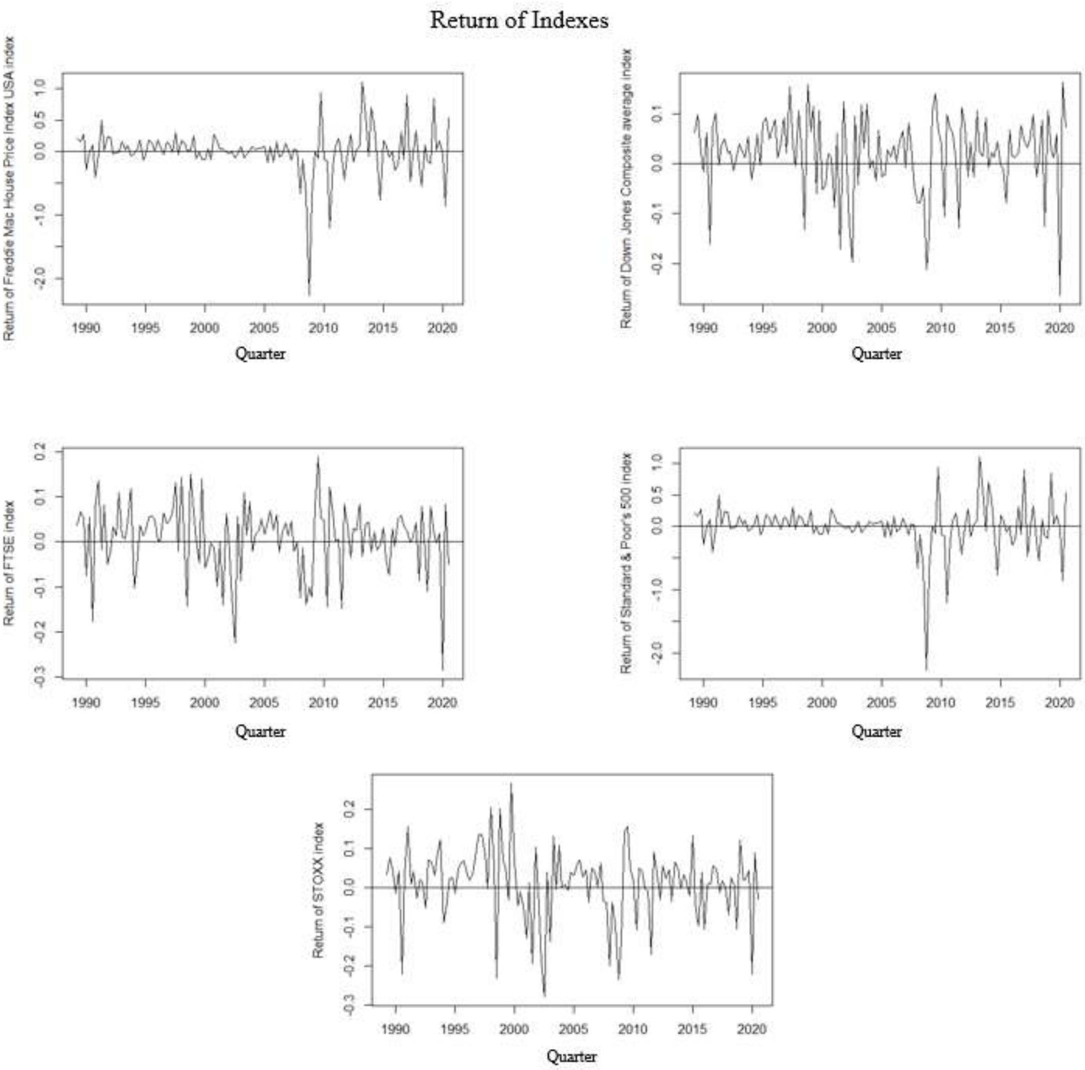

Figure 2 – Returns of indexes.

Alongside with descriptive statistics, it was verified if the time series are stationary (Table 3) through the ADF and Phillips and Perron (PP) tests. The ADF and PP tests do not reject the null hypothesis. The KPSS test rejected the null hypothesis indicating that the series are not stationary. The critical values for KPSS test are 0.74, 0.47 and 0.35 for 1%, 5% and 10% significance level, respectively.

	ADF	PP	KPSS
	p value		tf - value
DJIA	0.5661	0.4887	2.3051***
Freddie	0.597	0.5937	1.0925***
SPX	0.5007	0.5221	2.207***
FTSE	0.4757	0.5013	1.8786***
STOXX	0.6464	0.6533	1.3059***

Table 3 – Stationarity.

The first step to examine the existence of cointegration, it was to test the null hypothesis of no cointegration facing the threshold cointegration. If the null hypothesis is rejected, there is evidence of a long-run relationship among the indexes. Afterwards, it was tested if the adjustments processes are symmetric between the markets. In the case that the null hypothesis is rejected, there is threshold effect between the markets thus, the adjustments are asymmetric. To conclude, it was applied the threshold vector error correction of Enders and Granger (1998), to examine the wealth effect.

As previous mentioned, the markets can react in different ways to positive and negative shocks, which could result on asymmetric adjustments in the long run. Thus, a linear model that is based upon a symmetric adjustment may not be able to track those type of movements. Even so, it was computed the Engle-Granger cointegration for each combination of the indexes, as can be observed in the Table 4 and Table 5. The results reject the null hypothesis of no cointegration indicating that there is cointegration or wealth effect between those markets. The results of Freddie/DJIA are aligned with Chiang, Lee, & Tsai (2012)

	Drift		Trend		
	tau 2	phi1	thau3	phi2	phi3
Freddie/DJIA	-1.735	1.520	-1.974	1.411	2.101
Freddie/SPX	-1.705	1.465	-1.964	1.382	2.063
SPX/FTSE	0.715	0.764	-0.194	2.157	2.710
SPX/STOXX	0.873	1.411	-0.8265	2.536	2.743
DJIA/FTSE	-0.271	0.399	-1.211	1.771	2.284
DJIA/STOXX	0.088	0.717	-1.449	1.986	2.246

Table 4 - Results of linear cointegration tests.

Drift	1pct	5pct	10pct
tau2	-3.46	-2.88	-2.57
phi1	6.52	4.63	3.81

Trend	1pct	5pct	10pct
tau3	-3.99	-3.43	-3.13
phi2	6.22	4.75	4.07
phi3	8.43	6.49	5.47

Table 5 - Tests Statistics.

To examine potential asymmetry between the markets, MTAR model was computed, as represented in Table 6. The critical values for H_1 hypothesis was obtained from Enders and Siklos (2001). The null hypothesis (H1: no CI) it is not rejected in SPX/FTSE at 10% confidence level for TAR model and it is rejected across the board in MTAR model. In most of the cases, H1 is rejected thus, it indicates there is a long-run equilibrium between the indexes however, the adjustments are asymmetric. It was also computed F-statistics to verify the presence of asymmetric reversion in the data (H2: no APT) and it is rejected across the board. That suggests the reversions to the equilibrium take place at different paces.

Freddie/DJIA					Freddie/SPX				
item	tar	c.tar	mtar	c.mtar	item	tar	c.tar	mtar	c.mtar
lag	3	3	3	3	lag	3	3	3	3
thresh	0	-1.048	0	0.19	thresh	0	-1.09	0	0.187
pos.coeff	-0.016	-0.009	-0.028	0.051	pos.coeff	-0.016	-0.005	-0.025	0.049
pos.t.value	(-0.574)	(-0.341)	(-0.967)	(0.872)	pos.t.value	(-0.559)	(-0.187)	(-0.855)	(0.86)
neg.coeff	-0.055*	-0.067**	-0.043.	-0.049**	neg.coeff	-0.054*	-0.071**	-0.046.	-0.049**
neg.t.value	(-1.896)	(-2.212)	(-1.448)	(-2.213)	neg.t.value	(-1.892)	(-2.371)	(-1.551)	(-2.21)
total obs	127	127	127	127	total obs	127	127	127	127
coint obs	123	123	123	123	coint obs	123	123	123	123
aic	115.886	114.774	116.708	114.279	aic	116.66	114.866	117.329	115.057
bic	132.759	131.647	133.581	131.152	bic	133.533	131.739	134.202	131.93
LB test(4)	0.622	0.707	0.621	0.391	LB test(4)	0.619	0.742	0.638	0.395
LB test(8)	0.776	0.757	0.81	0.661	LB test(8)	0.771	0.761	0.815	0.661
LB test(12)	0.918	0.901	0.944	0.897	LB test(12)	0.911	0.889	0.943	0.894
H1: no CI	1.948	2.501	1.542	2.75	H1: no CI	1.932	2.827	1.601	2.731
H2: no APT	0.927	2.007	0.135	2.492	H2: no APT	0.914	2.66	0.269	2.474
H2: p.value	0.337	0.159	0.714	0.117	H2: p.value	0.341	0.106	0.605	0.118

SPX/FTSE					SPX/STOXX				
item	tar	c.tar	mtar	c.mtar	item	tar	c.tar	mtar	c.mtar
lag	3	3	3	3	lag	3	3	3	3
thresh	0	-0.136	0	0.004	thresh	0	-0.143	0	-0.037
pos.coeff	0.105*	0.104**	0.084.	0.094*	pos.coeff	0.038*	0.04*	0.003	0.007
pos.t.value	(1.879)	(2.033)	(1.588)	(1.782)	pos.t.value	(1.802)	(1.947)	(0.165)	(0.409)
neg.coeff	-0.088.	-0.134**	-0.095.	-0.106*	neg.coeff	-0.031	-0.04.	0.019	0.036
neg.t.value	(-1.537)	(-2.149)	(-1.52)	(-1.73)	neg.t.value	(-1.269)	(-1.579)	(0.707)	(0.647)
total obs	127	127	127	127	total obs	127	127	127	127
coint obs	123	123	123	123	coint obs	123	123	123	123
aic	-299.651	-302.832	-298.448	-299.971	aic	-359.686	-361.218	-354.981	-355.02
bic	-282.778	-285.959	-281.574	-283.098	bic	-342.813	-344.345	-338.108	-338.147
LB test(4)	0.995	0.995	0.951	0.934	LB test(4)	0.961	0.956	0.962	0.951
LB test(8)	0.994	0.993	0.979	0.971	LB test(8)	0.791	0.821	0.732	0.743
LB test(12)	1	0.998	0.999	0.998	LB test(12)	0.609	0.613	0.527	0.545
H1: no CI	3.373	5.007*	2.766	3.536	H1: no CI	2.568	3.34	0.257	0.276
H2: no APT	6.674**	9.941***	5.461**	7***	H2: no APT	4.828**	6.368**	0.219	0.256
H2: p.value	0.011	0.002	0.021	0.009	H2: p.value	0.03	0.013	0.641	0.614

Table 6 - TAR and MTAR cointegration tests (1).

*Denotes significance at the 10% level. **Denotes significance at the 5% level. ***Denotes significance at the 1% level.

DJIA/FTSE					DJIA/STOXX				
item	tar	c.tar	mtar	c.mtar	item	tar	c.tar	mtar	c.mtar
lag	3	3	3	3	lag	3	3	3	3
thresh	0	0.159	0	-0.009	thresh	0	-0.124	0	-0.002
pos.coeff	0.032	0.061	0.025	0.032	pos.coeff	0.022	0.025	-0.019	-0.02
pos.t.value	(0.561)	(1.03)	(0.518)	(0.683)	pos.t.value	(0.987)	(1.111)	(-0.927)	(-0.992)
neg.coeff	-0.084.	-0.094*	-0.128**	-0.162**	neg.coeff	-0.038.	-0.043*	0.022	0.027
neg.t.value	(-1.593)	(-1.877)	(-2.057)	(-2.475)	neg.t.value	(-1.564)	(-1.737)	(0.772)	(0.916)
total obs	127	127	127	127	total obs	127	127	127	127
coint obs	123	123	123	123	coint obs	123	123	123	123
aic	-267.038	-269.068	-268.754	-270.962	aic	-326.23	-327.1	-324.112	-324.505
bic	-250.165	-252.195	-251.881	-254.089	bic	-309.357	-310.227	-307.239	-307.632
LB test(4)	0.999	0.997	0.961	0.968	LB test(4)	0.999	0.999	0.999	0.998
LB test(8)	0.977	0.987	0.955	0.94	LB test(8)	0.812	0.802	0.697	0.668
LB test(12)	0.995	0.998	0.992	0.991	LB test(12)	0.724	0.727	0.607	0.585
H1: no CI	1.536	2.544	2.387	3.499	H1: no CI	1.789	2.221	0.751	0.943
H2: no APT	2.483	4.488**	4.176**	6.388**	H2: no APT	3.48*	4.342**	1.406	1.788
H2: p.value	0.118	0.036	0.043	0.013	H2: p.value	0.065	0.039	0.238	0.184

Tabela 7 - TAR and MTAR cointegration tests (2).

*Denotes significance at the 10% level. **Denotes significance at the 5% level. ***Denotes significance at the 1% level.

The next step was to estimate an asymmetric error correction model (Tables 8, 9 and 10). The estimated coefficient Φ^{+} does not represent statistical significance at any level. On the other hand, Φ^{-} presents significance at 5% confidence level in DJIA estimator (Freddie/DJIA) and at 10% is in SPX estimator (Freddie/SPX) and FTSE estimator (SPX/FTSE and DJIA/FTSE). If the estimated coefficient Φ^{-} has statistically significance it means that the price only reacts to a negative deviation. Hence, the response for a negative deviation where the price of one index outperforms the other by any estimated threshold level, it is triggered an increase on the second index and "then the two markets are cointegrated" (Tsai, 2012).

The results of the comparison between the housing market and DJIA, the results are similar to Chiang, Lee, & Tsai (2012), however the coefficient Φ^{+} is statistically significant at 5% confidence level. Moreover, the causality relation given by H01 presents a "one-way relationship" with the U.S. stock market. Moreover, the results between the housing market and DJIA are similar to the results obtained with SPX and housing market. These results are aligned with the hypothesis 1 and 2 that confirms the existence of an “asymmetric wealth effect between the U.S. housing and stock markets”.

Regarding the comparison between the U.S. stock market and European stock market, the results of the indexes SPX/FTSE and DJIA/FTSE are comparable as the U.S. housing market and U.S. stock market. There is evidence of cointegration and a one-way causal relationship and the coefficient Φ^- is significant at 10% confidence level. The results of DJIA and FTSE are aligned with SPX and FTSE. Regarding the results of STOXX with DJIA and FTSE, almost none of the values are statistically significant.

	Freddie/DJIA				Freddie/SPX			
item	DJIA.est	DJIA.t	Freddie.est	Freddie.t	SPX.est	SPX.t	Freddie.est	Freddie.t
(Intercept)	0.012	0.552	0.023	0.251	-0.002	-0.082	0.026	0.297
α_1^+	0.02	0.088	2.551**	2.584	0.137	0.615	2.046**	2.22
α_2^+	0.374*	1.674	-0.131	-0.135	0.594***	2.665	0.421	0.457
α_3^+	0.185	0.812	-0.148	-0.15	0.092	0.416	-0.306	-0.334
α_4^+	-0.331.	-1.601	-0.713	-0.791	-0.256	-1.236	-0.675	-0.788
α_1^-	-0.401**	-2.266	1.686**	2.186	-0.335*	-1.846	1.943**	2.594
α_2^-	-0.311.	-1.583	0.141	0.165	-0.362*	-1.823	-0.547	-0.668
α_3^-	0.058	0.267	0.278	0.295	0.259	1.23	0.891	1.025
α_4^-	0.263	1.213	-0.129	-0.137	0.121	0.573	-0.618	-0.709
β_1^+	-0.013	-0.301	-0.087	-0.456	-0.036	-0.8	-0.086	-0.468
β_2^+	0.011	0.268	0.016	0.089	0.024	0.573	0.014	0.079
β_3^+	0.014	0.344	-0.094	-0.532	0.014	0.331	-0.084	-0.486
β_4^+	-0.01	-0.25	0.027	0.152	0.006	0.141	0.022	0.129
β_1^-	0.074**	2.362	0.356***	2.61	0.065*	1.942	0.356**	2.583
β_2^-	0.01	0.315	-0.149	-1.056	0.006	0.169	-0.109	-0.762
β_3^-	0.001	0.039	0.352**	2.468	-0.004	-0.122	0.338**	2.366
β_4^-	0.002	0.056	-0.258*	-1.825	0.018	0.534	-0.245*	-1.76
Φ^+	0.005	0.34	-0.01	-0.163	0	-0.026	0.014	0.233
Φ^-	**-0.012****	-2.102	-0.034	-1.421	**-0.011***	-1.911	-0.036.	-1.526
H01:α_1^+=α_2^+= 0 for all lags	1.591.	[0.14]	3.276***	[0]	1.563.	[0.14]	3.652***	[0]
H02: β_1^+=β_2^+=0 for all lags	0.844	[0.57]	1.602.	[0.13]	0.684	[0.7]	1.564.	[0.14]

Table 8 - Error correction model (1).

*Denotes significance at the 10% level. **Denotes significance at the 5% level. ***Denotes significance at the 1% level.

	SPX/FTSE				SPX/STOXX			
item	FTSE.est	FTSE.t	SPX.est	SPX.t	STOXX.est	STOXX.t	SPX.est	SPX.t
(Intercept)	-0.014	-0.727	-0.024	-1.198	-0.027	-1.119	-0.018	-0.88
α_1^+	0.568*	1.925	0.881***	2.949	0.431	1.38	0.464*	1.776
α_2^+	-0.315	-1.087	-0.341	-1.163	-0.436.	-1.525	-0.26	-1.087
α_3^+	-0.042	-0.144	0.06	0.203	0.197	0.698	0.151	0.639
α_4^+	0.432.	1.49	0.114	0.388	0.092	0.327	-0.046	-0.192
α_1^-	-0.904***	-2.628	-0.829**	-2.378	-0.486	-1.329	-0.464.	-1.515
α_2^-	0.333	0.996	0.252	0.744	0.054	0.147	-0.073	-0.236
α_3^-	0.345	0.987	0.181	0.511	0.278	0.772	0.234	0.776
α_4^-	-0.608*	-1.702	-0.496	-1.371	0.244	0.679	0.298	0.991
β_1^+	-0.225	-0.809	-0.261	-0.925	-0.121	-0.352	-0.162	-0.562
β_2^+	0.534*	1.952	0.784***	2.827	0.817**	2.388	0.808***	2.818
β_3^+	0.04	0.146	0.111	0.402	0.082	0.238	0.056	0.195
β_4^+	-0.399.	-1.511	-0.271	-1.013	-0.168	-0.521	-0.172	-0.635
β_1^-	0.665*	1.918	0.442	1.26	0.336	0.763	0.216	0.586
β_2^-	-0.32	-0.966	-0.435	-1.293	-0.119	-0.264	-0.195	-0.516
β_3^-	-0.266	-0.793	0.033	0.097	-0.218	-0.477	-0.06	-0.158
β_4^-	0.527.	1.578	0.623*	1.841	-0.091	-0.204	-0.123	-0.329
Φ^+	-0.046	-0.738	0.008	0.128	0.028	0.84	0.041.	1.477
Φ^-	**0.134***	1.791	0.122.	1.619	-0.025	-0.219	0.055	0.563
H01:α_1^+=α_2^+= 0 for all lags	1.692.	[0.11]	1.96*	[0.06]	0.968	[0.47]	1.123	[0.35]
H02: β_1^+=β_2^+=0 for all lags	1.345	[0.23]	1.576.	[0.14]	0.845	[0.56]	1.139	[0.34]

Table 9 - Error correction model (2).

*Denotes significance at the 10% level. **Denotes significance at the 5% level. ***Denotes significance at the 1% level.

	DJIA/FTSE				DJIA/STOXX			
item	FTSE.est	FTSE.t	DJIA.est	DJIA.t	STOXX.est	STOXX.t	DJIA.est	DJIA.t
(Intercept)	-0.018	-0.911	-0.017	-0.841	-0.021	-0.814	-0.008	-0.386
α_1^+	0.705***	2.653	0.775***	2.885	0.538**	2.114	0.351*	1.675
α_2^+	0.1	0.399	0.172	0.679	-0.151	-0.577	0.003	0.015
α_3^+	0.126	0.505	0.159	0.631	0.233	0.921	0.165	0.794
α_4^+	0.347	1.399	0.123	0.49	0.122	0.48	0.146	0.701
α_1^-	-0.407	-1.157	-0.15	-0.421	0.11	0.305	0.273	0.918
α_2^-	0.659*	1.868	0.21	0.588	0.077	0.214	-0.209	-0.706
α_3^-	0.091	0.254	-0.151	-0.418	-0.009	-0.023	-0.128	-0.413
α_4^-	-0.77**	-2.181	-0.608*	-1.705	-0.127	-0.327	-0.006	-0.018
β_1^+	-0.343	-1.375	-0.308	-1.224	-0.295	-0.913	-0.126	-0.473
β_2^+	0.308	1.212	0.296	1.151	0.455	1.441	0.403.	1.551
β_3^+	0.006	0.022	0.104	0.412	0.107	0.337	0.083	0.317
β_4^+	-0.43*	-1.781	-0.357.	-1.463	-0.268	-0.88	-0.388.	-1.545
β_1^-	0.098	0.273	-0.254	-0.695	-0.399	-0.888	-0.653*	-1.765
β_2^-	-0.722*	-1.977	-0.339	-0.918	-0.138	-0.302	0.098	0.26
β_3^-	-0.004	-0.011	0.232	0.621	0.032	0.063	0.149	0.354
β_4^-	0.926**	2.581	0.905**	2.495	0.444	0.871	0.341	0.811
Φ^+	-0.007	-0.145	0.029	0.587	0.035	1.021	0.019	0.658
Φ^-	**0.135***	1.881	0.039	0.54	0.016	0.308	0.065.	1.485
H01:α_1^+=α_2^+= 0 for all lags	1.87*	[0.07]	1.295	[0.25]	0.78	[0.62]	0.691	[0.7]
H02: β_1^+=β_2^+=0 for all lags	1.799*	[0.09]	1.402	[0.2]	0.711	[0.68]	1.158	[0.33]

Table 10 - Error correction model (3).

*Denotes significance at the 10% level. **Denotes significance at the 5% level. ***Denotes significance at the 1% level.

Proving the asymmetric wealth effect leads to significant implications for the investors and portfolio managers. That effect enables the investor to ride the booming markets and obtain a hedge against negative economic conditions. In those markets the investor, who is exposed to real estate, can benefit substantial capital gains as well the appreciation of the real estate. On the other hand, when there is a decline in the markets, the investor benefits from the diversification.

Previous studies tried to reach results that support a long-run relationship between the housing market and stock market however, the approach might not be indicated. Those studies adopted a linear approach which could lead to misinformation if the long-run equilibrium relationship is non-linear. Chiang, Lee, & Tsai (2012) proposed the application of MTAR and TAR models due to the different reaction of stock and housing market whenever occurs a positive or negative shock and "the asymmetry can have a potential impact on their long-run relationship". Moreover, empirical results that if it is not considered asymmetric behaviours in the relationship amongst the markets, linear models result will mislead on the adjustments in the disequilibrium. For that reasons, this study follows the methodology of Chiang, Lee, & Tsai (2012) and employs two non-linear models.

This study aims to: (1) update the results of Chiang, Lee, & Tsai (2012) as well as testing new indexes; (2) verify potential asymmetric relationship with the indexes. To reach that conclusion, two hypotheses were tested being the first the evidence of cointegration between the markets and second the wealth effect between the markets and if it is more significant when the "stock price outperforms the housing price over a certain level". The first step was to test the asymmetric cointegration through the MTAR model and the results are similar to Chiang, Lee, & Tsai (2012) on which it was found that there is a long-run equilibrium relationship between Freddie and DJIA however the adjustments are asymmetric. Regarding the results for the tests between stock markets, only the STOXX index does not show statistical significance. The second step was to run an asymmetric error correction model to verify the wealth effect. Likewise, the results from the first step, the results obtained from the verification of wealth effect follow Chiang, Lee, & Tsai (2012). Whenever the stock price outperforms the housing market above an estimated threshold, the wealth effect is more powerful. Moreover, when a certain level is reached between the difference of stock price and housing/another stock price, the second declines, therefore it exists cointegration amidst the market, in that market conditions.

- Abdulai, A., (2002). Using threshold cointegration to estimate asymmetric price transmission in the Swiss pork market. Applied Economics 34, 679–687.
- Adams, Z., & Fuss, R. (2010). Macroeconomic determinants of international housing markets. Journal of Housing Economics, 19(1),38–50.
- Ambrose, B., Ancel, E., Griffiths, M. (1992). The fractal structure of real estate investment trust returns: a search for evidence of market segmentation and nonlinear dependency. Journal of the American Real Estate and Urban Economics Association, 20(1), 25-54.
- Andrews, E. & Ziot, D. W. K. (2002). Further Evidence on the Great Crash, the Oil-Price Shock, and the Unit-Root Hypothesis. Journal of Business & Economic Statistics, 20, 1, 25–44.
- Arshanapalli, B. and Doukas, J. (1993) International stock market linkages: evidence from the pre- and post-October 1987 period. Journal of Banking and Finance, 17, 193Ð 208.
- Arshanapalli, B., J. Doukas and L. Lang. (1995). Pre and Post-October 1987 Stock Market Linkages between US and Asian Markets, Pacific-Basin Finance Journal, 3: 57–73.
- Aye, G., Balcilar, M., Gupta, R. (2013). Long-and short-run relationships between house and stock prices in South Africa: a nonparametric approach. J. Hous. Res. 22 (2), 203–219.
- Bahmani-Oskooee, M., & Ghodsi, H. (2018). Asymmetric causality between the U.S. housing market and its stock market: evidence from state level data. J. Econ. Asymmetries 18, e00095. https://doi.org/10.1016/j.jeca.2018.e00095.
- Bahmani-Oskooee, M., & Wu, T.-P. (2017). Housing prices and real effective exchange rates in 18 OECD countries: a bootstrap multivariate panel Granger causality. Economic Analysis and Policy, 60, 119-126
- Bai J, & Perron P. (1998) Estimating and testing linear models with multiple structural changes. Econometrica 66(1):47–78
- Bai, B. Y. J., & Perron, P. (2012). Estimating and Testing Linear Models with Multiple Structural Changes. The Econometric Society, 66,1, 47–78.
- Bai, J., & Perron, P. (2003). Computation and analysis of multiple structural change models. Journal of Applied Econometrics, 18,1, 1–22. https://doi.org/10.1002/jae.659
- Balke, N.S., Fomby, T., (1997). Threshold cointegration. International Economic Review 38, 627–645.
- Black, F. (1976). Studies in stock price volatility changes. Proceedings of the Meetings of the American Statistical Association, Business and Economics Statistics Division, 177–181.
- Blume, M. E., & Friend, I. (1973). A New Look at the Capital Asset Pricing Model. Journal of Finance 28, 19-33.
- Bouchouicha, R. (2013). Dynamics of real estate markets and stock markets in the US and the UK. Working paper series.
- Byers, J. D. & Peel, D. A. (1993) Some evidence of interdependence of national stock markets and the gains from international portfolio diversification. Applied Financial Economics, 3, 239Ð 42.
- Case, K. E., Quigley J. M., & Shiller, R. J. (2005). Comparing Wealth Effects: The Stock Market versus the Housing Market. Advances in Macroeconomics 5: 1–32. doi:10.2202/1534-6013.1235.

- Case, K.E., Shiller, R.J. (1989). The efficiency of the market for single family homes. The American Economic Review 79, 125–137.
- Chan, K.S., (1993). Consistency and limiting distribution of the least squares estimator of a threshold autoregressive model. The Annals of Statistics 21, 520–533.
- Chauvet. M., (1998-1999). Stock market fluctuations and the business cycle. Journal of Economic and Social Measurement, 25, 235-257.
- Chen, N. (2001). Asset Price Fluctuations in Taiwan: Evidence from Stock and Real Estate Prices 1973 to 1992. Journal of Asian Economics 12 (2): 215–232. doi:10.1016/S1049-0078(01)00083-5.
- Choudhry, T. & Lu Lin. (2004). Common Stochastic Trends among Far East Stock Prices: Effects of the Asian Financial Crisis, paper presented at European Financial Management Association 2004 Annual Meeting, Basle.
- Dickey, D., Fuller, W.A., (1979). Distribution of the estimators for autoregressive time series with a unit root. Journal of the American Statistical Association 74, 427–431.
- Ding, H., T. T.-L. Chong, & Park,S. Y. (2014). Nonlinear Dependence between Stock and Real Estate Markets in China. Economics Letters 124: 526–529. doi:10.1016/j.econlet.2014.05.035.
- Dufrénot, G., Malik, S. (2010). The changing role of house price dynamics over the business cycle. Working paper (the Banque de France Website).
- Edison, Hali J. & Warnock, F. (2001). 'A Simple Measure of the Intensity of Capital Controls', IMF Working Paper No. WP/01/180.
- Eichholtz, P. M., Hartzell, D. J. (1996). Property shares, appraisals and the stock market: na international perspective. The Journal of Real Estate Finance and Economics, 12(2), 163-178.
- Enders, W., 2004. Applied Econometric Time Series. John Wiley & Sons, Inc., New York. 480 p.
- Enders, W., Granger, C.W.J., (1998). Unit-root tests and asymmetric adjustment with an example using the term structure of interest rates. Journal of Business & Economic Statistics 16, 304–311.
- Enders, W., Siklos, P.L., (2001). Cointegration and threshold adjustment. Journal of Business and Economic Statistics 19, 166–176.
- Engle, R. B., & Yoo, B. S. (1987): Forecasting and Testing in Cointegrated Systems, Journal of Econometrics, 35,143- 159.
- Engle, R. F., & Granger, C. W. J. (1987). Co-Integration and Error Correction: Representation, Estimation, and Testing. Econometrica, 55, 2, 251. doi:10.2307/1913236
- Fama, E. F., & MacBeth, J. D. (1973). Risk, return, and equilibrium: Empirical tests. Journal of Political Economy, 81, 3, 607–636. https://doi.org/10.1086/260061
- Figlewski, S., & Wang, X. (2005). Is the Leverage Effect a Leverage Effect? SSRN Electronic Journal, 852. https://doi.org/10.2139/ssrn.256109
- Fuller, W. A. (1976): Introduction to Statistical Time Series, New York: Wiley, State: Publisher
- Geltner, D. (1990). Return risk and cash flow with long term riskless leases in comercial real estate. Journal of the American Real Estate and Urban Economics Association, 18(4), 377-402.

- Ghosh, Asim, R. Saidi & Johnson, K.H.(1999). 'Who Moves the Asia-Pacific Stock Markets: U.S. or Japan? Empirical Evidence Based on the Theory of Cointegration', The Financial Review, 34(1): 159–70
- Granger, C. W. J. (1981). Some properties of time series data and their use in econometric model specification. Journal of Econometrics, 16, 1, 121–130. https://doi.org/10.1016/0304-4076(81)90079-8
- Granger, C. W. J., & Weiss, A. A. (1983). Time Series Analysis of Error-Correcting Models, in Studies in Econometrics, Time Series, and Multivariate Statistics. New York: Academic Press, 255-278.
- Granger, C.W.J., Lee, T.H., (1989). Investigation of production, sales, and inventory relationships using multicointegration and non-symmetric error correction models. Journal of Applied Economics 4, 145–159.
- Green, R. K. (2002). Stock prices and house prices in California: new evidence of a wealth effect? Regional Science and Urban Economics, 32, 775–783.
- Gregory, A.W., & Hansen, B.E. (1996). Residual-based tests for cointegration in models with regime shifts. J Econometrics 70, 99–126
- Guo, F., & Huang, Y. S. (2010). Does hot money drive China's real estate and stock markets? International Reviews of Economics and Finance, 19(3), 452–466.
- Gyourko, J., Keim, D. (1992). What does the stock market tell us about real estate returns? Journal of the American Real Estate Finance and Urban Economics Association, 20(3), 457-486
- Hartzell, D. (1986). Real estate in the portfolio, in F. J. Fabozzi, eds., The Institutional Investor: Focus on Investment Management, Ballinger, Cambridge, Massachusetts.
- Hatemi-J, A. (2008). Tests for cointegration with two unknown regime shifts with an application to financial market integration. Empirical Economics, 35, 3, 497–505. https://doi.org/10.1007/s00181-007-0175-9
- Ibbotson, R. G., & Siegel, L. B. (1984). Real Estate Returns: A Comparison with Other Investments. Real Estate Economics, 12, 3, 219–242. doi:10.1111/1540-6229.00320
- Jorion, P. (1985). International Portfolio Diversification with Estimation Risk. The Journal of Business, 58(3), 259. https://doi.org/10.1086/296296
- Jorion, P., Schwartz, E. (1986). Integration vs. segmentation in the Canadian stock market. Journal of Finance, 41(3), 603-616.
- Kanas, A. (1998) Linkages between the US and European equity markets: further evidence from cointegration tests. Applied Financial Economics, 8:6, 607-614.
- Kapopoulos, P., & Siokis, F. (2005). Stock and Real Estate Prices in Greece: Wealth versus 'Credit-Price' Effect. Applied Economics Letters 12 (2): 125–128. doi:10.1080/1350485042000307107.
- Kasa, K. (1992) Common stochastic trends in international stock markets. Journal of Monetary Economics, 29, 95Ð 124.
- Kim, Suk-Joong. (2005). Information Leadership in the Advanced Asia-Pacific Stock Markets: Return, Volatility and Volume Information Spillovers from the US and Japan, Journal of the Japanese and International Economies, 19(3): 338–65.
- Kwiatkowski, D., Phillips, P. C. B., Schmidt, P. & Shin, Y. (1992). `Testing for the Null of Stationarity Against the Alternative of a Unit Root', Journal of Econometrics, 54, 159-178.

- Leamer, E. E., (2007). Housing is the business cycle. In Housing, Housing Finance, and Monetary Policy, Economic Symposium Conference Proceedings, Kansas City Federal Reserve Bank, 149-233.
- Lean, H. H. (2012). Wealth Effect or Credit-Price Effect? Evidence from Malaysia. Procedia Economics and Finance 1: 259–268. doi:10.1016/S2212-5671(12)00030-5.
- Li, Y., & Wang, K. (1995). The predictability of REIT returns and market segmentation. The Journal of Real Estate Research, 10(4),471–482.
- Lin, P. T., & Fuerst, F. (2014). The integration of direct real estate and stock markets in Asia. Applied Economics, 46(12), 1323–1334.
- Liow, K. H. (2006). Dynamic relationship between stock and property markets. Applied Financial Economics, 16, 371–376.
- Liow, K. H., Yang, H. S. (2005). Long-term co-memories and short-run adjustment: securitized real estate and stock markets. The Journal of Real Estate Finance and Economics, 31(3), 283-300.
- Litterman, R.B., (1986). Forecasting with Bayesian vector autoregressions: Five years of experience. Journal of Business and Economic Statistics 4, 25-38.
- Liu, C. H., Hartzell, D. J., Greig, W., & Grissom, T. V. (1990). The integration of the real estate market and the stock market: Some preliminary evidence. The Journal of Real Estate Finance and Economics, 3, 3, 261–282. https://doi.org/10.1007/BF00216190
- Liu, Y. S., & Su, C. W. (2010). The relationship between the real estate and stock markets of China: Evidence from a nonlinear model. Applied Financial Economics, 20(22), 1741–1749.
- Lou, T. (2016). Nonlinear causality relationship between stock and real-estate returns in PIGS countries: wealth effect or credit-price effect. Applied Economics Letters, 24(11), 736–741. https://doi.org/10.1080/13504851.2016.1226480
- Lowenfeld, H., lnvestmen~ An Exact Science (London: The Financial Review of Reviews, 1909).
- MacKinnon, J. G. (1991). Critical Values for Co-Integration Tests. Long-Run Economic Relationships: Readings in Cointegration, (1227), 267–276. https://doi.org/10.1111/1468-0084.61.s1.14
- Manning, N. (2002). ‘Common Trends and Convergences? South East Asian Equity Markets, 1988–1999’, Journal of International Money and Finance, 21:183–202.
- McDonald, J. F., & Stokes, H. H. (2013). Monetary policy and the housing bubble. Journal of Real Estate Finance and Economics,46(3), 437–451.
- McMillan, D. (2012). Long-run stock price-house price relation: evidence from an ESTR model. Economics Bulletin, 32(2), 1737-1746.
- Moore, G. H., (1983). Security markets and business cycles. In Business Cycles, Inflation, and Forecasting, 2nd edition. (Ed.) Moore, G. H., NBER Book Series Studies in Business Cycles, 139-160.
- Myer, F. C. N., Webb, J. R. (1993). Return properties of equity REITs, common stocks, and commercial real estate: a comparison. Journal of Real Estate Research, 8(1), 87-106.
- Officer, R. R. (1973). The variability of the market factor of the New York stock exchange. The Journal of Business, 46, 434–453.
- Okunev, J., & Wilson, P. J. (1997). Using nonlinear tests to examine integration between real estate and stock markets. Real Estate Economics, 25(3), 487–503.

- Okunev, J., P. Wilson, & R. Zurbruegg. (2000). The Causal Relationship between Real Estate and Stock Markets. The Journal of Real Estate Finance and Economics 21 (3): 251– 261. doi:10.1023/A:1012051719424.
- Okunev, J., Wilson, P., & Zurbruegg, R. (2002). Relationships between Australian real estate and stock market prices: A case of market inefficiency. Journal of Forecasting, 21(3), 181–192.
- Ong, S. E. (1995). Singapore real estate and property stocks—a cointegraton test. Journal of Property Research, 12(1), 29–39.
- Perron, P. (1989). The great crash, the oil price shock and the unit root hypothesis. Econometrica 57, 6, 1361–1401.
- Phillips, P. C. B. & Ouliaris, S. (1990). Asymptotic properties of residual based tests for cointegration. Econometrica, 58, 165–193.
- Phylaktis, Kate & F. Ravazzolo. 2002. 'Stock Market Linkages in Emerging Markets: Implications for International Portfolio Diversification', Working Paper 2/2002, Emerging Markets Group, Cass Business School.
- Quan, C. D., & Titman, S. (1997). Commercial real estate prices and stock market returns: an international analysis. Financial Analysts Journal, 53, 3, 21–34.
- Quan, C. D., Titman, S. (1999). Do real estate prices and stock prices move together? An international analysis. Real Estate Economics, 27(2), 183-207.
- Roll, R. (1977). A Critique of the Asset Pricing Theory's Tests. Journal of Financial Economics 4, 129-176.
- Schwert, W. (1989). Why does stock market volatility change over time? Journal of Finance, 44, 1115– 1153.
- Shen, C.H., Chen, C.F., Chen, L.H., (2007). An empirical study of the asymmetric cointegration relationships among the Chinese stock markets. Applied Economics 39, 1433–1445.
- Shiller, R. J. (1993). Macro markets: Creating institutions for managing society's largest economic risks. Oxford: Oxford University Press.
- Shiller, R. J. (2005). Irrational exuberance (2nd ed.). Princeton, NJ: Doubleday.
- Shiller, R. J. (2009). The subprime solution. Princeton, NJ: Princeton University Press
- Shirvani, H., Mirshab, B., Delcoure, N. N. (2012). Stock prices, home prices, and private consumption in the US: Some robust bilateral causality tests. Modern Economy, 3, 145-149.
- Siegel, J. J., (1991). The behaviour of stock returns around N.B.E.R. turning points: An overview. Rodney L. White Enter for Financial Research, Philadelphia, PA.
- Sim, S., & B. Chang. (2006). Stock and Real Estate Markets in Korea: Wealth or Credit Price Effect. Journal Economics Researcher 11 (1): 99–121.
- Sims, C.A. (1980), Macroeconomics and reality. Econometrica 48, 1, 1-48.
- Sousa, R. M. (2010). Housing wealth, financial wealth, money demand and policy rule: Evidence from the euro area. North American Journal of Economics and Finance, 21(1), 88–105.
- Srivastava, A. (2007). Cointegration of Asian Markets with US Markets: International Diversification Perspectives. Global Business Review, 8(2), 251–265. https://doi.org/10.1177/097215090700800205
- Stehle, R. (1997). An Empirical Test of the Alternative Hypotheses of National and International Pricing of Risky Assets. Journal of Finance 32, 493-502.

- Su, C. W. (2011). Non-linear causality between the stock and real estate markets of Western European countries: evidence from rank tests. Economic Modelling, 28, 845-851.
- Su, C. W., Chang, H. L., Zhu, M. N. (2011). A non-linear model of causality between the stock and real estate markets of European countries. Romanian Journal of Economic Forecasting, 1, 41-53.
- Sun, C. (2011). Price dynamics in the import wooden bed market of the United States. Forest Policy and Economics, 13(6), 479–487. https://doi.org/10.1016/j.forpol.2011.05.009
- Taylor, J.B. (2007). Housing and monetary policy. NBER Working Paper Series 13682. National Bureau of Economic Research, Cambridge, Mass (December, www.nber.org/ papers/w13682.pdf).
- Taylor, M. P. & Tonks, I. (1989) The internationalisation of stock markets and the abolition of UK exchange control. Review of Economics and Statistics, 71, 332Ð 6.
- Tong, H. (1983), Threshold Models in Nonlinear Time SeriesAnalysis (Lecture Notes in Statistics No. 21), New York: Springer-Verlag
- Tong, H. (1978) On a threshold model. In: Chen, C, (ed.) Pattern Recognition and Signal Processing. NATO ASI Series E: Applied Sc. (29). Sijthoff & Noordhoff, Netherlands, pp. 575-586. ISBN 9789028609785
- Tong, H., & Lim, K. S. (1980), Threshold Autoregression, Limit Cycles and Cyclical Data (with discussion), Journal of the Royal Statistical Society, Ser. B, 42, 245-292
- Tsai, I. C. (2015). Dynamic information transfer in the United States housing and stock markets. North American Journal of Economics and Finance, 34, 215–230. https://doi.org/10.1016/j.najef.2015.09.012
- Tsai, I. C., Lee, C. F., & Chiang, M. C. (2012). The asymmetric wealth effect in the US housing and stock markets: Evidence from the threshold cointegration model. The Journal of Real Estate Finance and Economics, 45(4), 1005–1020.
- Wilson, P. & Okunev, J. (1999). Long-term dependencies and long run non-periodic co-cycles: Real estate and stock markets. Journal of Real Estate Research, 18(2), 257-278.
- Worzala, E., & Vandell, K. (1993). International direct real estate investments as alternative portfolio assets for institutional investors: An evaluation. Paper presented at the 1993 AREUEA meetings, Anaheim, CA, USA.
- Worzala, E., Vandell, K. (1993). International direct real estate investments as alternative portfolio assets for institutional investors: an evaluation. The AREUEA conference paper, Anaheim, CA. USA.
- Xiao-Lin, L., S. M. Tsangyao Chang, M. B. Miller, and R. Guptae. (2015). The Co-Movement and Causality between the U.S. Housing and Stock Markets in the Time and Frequency Domains. International Review of Economics and Finance 38: 220–233. doi:10.1016/j.iref.2015.02.028.
- Yang, T. & J. J. Lim. (2002). Crisis, Contagion, and East Asian Stock Markets, Working Paper Economics and Finance No 1, February 2002, Institute of South East Asian Studies.
- Zivot E, Andrews DWK (1992) Further evidence on the great crash, the oil shock, and the unit-root hypothesis. J Bus Econ Stat 10:251–270

Appendix I – Threshold Cointegration Tests

Freddie/DJIA					Freddie/SPX				
item	tar	c.tar	mtar	c.mtar	item	tar	c.tar	mtar	c.mtar
lag	3	3	3	3	lag	3	3	3	3
thresh	0	-1.048	0	0.19	thresh	0	-1.09	0	0.187
pos.coeff	-0.016	-0.009	-0.028	0.051	pos.coeff	-0.016	-0.005	-0.025	0.049
pos.t.value	(-0.574)	(-0.341)	(-0.967)	(0.872)	pos.t.value	(-0.559)	(-0.187)	(-0.855)	(0.86)
neg.coeff	-0.055*	-0.067**	-0.043.	-0.049**	neg.coeff	-0.054*	-0.071**	-0.046.	-0.049**
neg.t.value	(-1.896)	(-2.212)	(-1.448)	(-2.213)	neg.t.value	(-1.892)	(-2.371)	(-1.551)	(-2.21)
total obs	127	127	127	127	total obs	127	127	127	127
coint obs	123	123	123	123	coint obs	123	123	123	123
aic	115.886	114.774	116.708	114.279	aic	116.66	114.866	117.329	115.057
bic	132.759	131.647	133.581	131.152	bic	133.533	131.739	134.202	131.93
LB test(4)	0.622	0.707	0.621	0.391	LB test(4)	0.619	0.742	0.638	0.395
LB test(8)	0.776	0.757	0.81	0.661	LB test(8)	0.771	0.761	0.815	0.661
LB test(12)	0.918	0.901	0.944	0.897	LB test(12)	0.911	0.889	0.943	0.894
H1: no CI	1.948	2.501	1.542	2.75	H1: no CI	1.932	2.827	1.601	2.731
H2: no APT	0.927	2.007	0.135	2.492	H2: no APT	0.914	2.66	0.269	2.474
H2: p.value	0.337	0.159	0.714	0.117	H2: p.value	0.341	0.106	0.605	0.118

Table 11 - Threshold cointegration tests Freddie.

*Denotes significance at the 10% level. ** Denotes significance at the 5% level. ***Denotes significance at the 1% level

SPX/FTSE					SPX/STOXX				
Item	tar	c.tar	mtar	c.mtar	item	tar	c.tar	mtar	c.mtar
Lag	3	3	3	3	lag	3	3	3	3
Thresh	0	-0.136	0	0.004	thresh	0	-0.143	0	-0.037
pos.coeff	0.105*	0.104**	0.084.	0.094*	pos.coeff	0.038*	0.04*	0.003	0.007
pos.t.value	(1.879)	(2.033)	(1.588)	(1.782)	pos.t.value	(1.802)	(1.947)	(0.165)	(0.409)
neg.coeff	-0.088.	-0.134**	-0.095.	-0.106*	neg.coeff	-0.031	-0.04.	0.019	0.036
neg.t.value	(-1.537)	(-2.149)	(-1.52)	(-1.73)	neg.t.value	(-1.269)	(-1.579)	(0.707)	(0.647)
total obs	127	127	127	127	total obs	127	127	127	127
coint obs	123	123	123	123	coint obs	123	123	123	123
aic	-299.651	-302.832	-298.448	-299.971	aic	-359.686	-361.218	-354.981	-355.02
bic	-282.778	-285.959	-281.574	-283.098	bic	-342.813	-344.345	-338.108	-338.147
LB test(4)	0.995	0.995	0.951	0.934	LB test(4)	0.961	0.956	0.962	0.951
LB test(8)	0.994	0.993	0.979	0.971	LB test(8)	0.791	0.821	0.732	0.743
LB test(12)	1	0.998	0.999	0.998	LB test(12)	0.609	0.613	0.527	0.545
H1: no CI	3.373	5.007*	2.766	3.536	H1: no CI	2.568	3.34	0.257	0.276
H2: no APT	6.674**	9.941***	5.461**	7***	H2: no APT	4.828**	6.368**	0.219	0.256
H2: p.value	0.011	0.002	0.021	0.009	H2: p.value	0.03	0.013	0.641	0.614

Table 12 - Threshold cointegration tests SPX.

*Denotes significance at the 10% level. **Denotes significance at the 5% level. ***Denotes significance at the 1% level

DJIA/FTSE					DJIA/STOXX				
item	tar	c.tar	mtar	c.mtar	item	tar	c.tar	mtar	c.mtar
lag	3	3	3	3	lag	3	3	3	3
thresh	0	0.159	0	-0.009	thresh	0	-0.124	0	-0.002
pos.coeff	0.032	0.061	0.025	0.032	pos.coeff	0.022	0.025	-0.019	-0.02
pos.t.value	(0.561)	(1.03)	(0.518)	(0.683)	pos.t.value	(0.987)	(1.111)	(-0.927)	(-0.992)
neg.coeff	-0.084.	-0.094*	-0.128**	-0.162**	neg.coeff	-0.038.	-0.043*	0.022	0.027
neg.t.value	(-1.593)	(-1.877)	(-2.057)	(-2.475)	neg.t.value	(-1.564)	(-1.737)	(0.772)	(0.916)
total obs	127	127	127	127	total obs	127	127	127	127
coint obs	123	123	123	123	coint obs	123	123	123	123
aic	-267.038	-269.068	-268.754	-270.962	aic	-326.23	-327.1	-324.112	-324.505
bic	-250.165	-252.195	-251.881	-254.089	bic	-309.357	-310.227	-307.239	-307.632
LB test(4)	0.999	0.997	0.961	0.968	LB test(4)	0.999	0.999	0.999	0.998
LB test(8)	0.977	0.987	0.955	0.94	LB test(8)	0.812	0.802	0.697	0.668
LB test(12)	0.995	0.998	0.992	0.991	LB test(12)	0.724	0.727	0.607	0.585
H1: no CI	1.536	2.544	2.387	3.499	H1: no CI	1.789	2.221	0.751	0.943
H2: no APT	2.483	4.488**	4.176**	6.388**	H2: no APT	3.48*	4.342**	1.406	1.788
H2: p.value	0.118	0.036	0.043	0.013	H2: p.value	0.065	0.039	0.238	0.184

Table 13 - Threshold cointegration tests DJIA.

*Denotes significance at the 10% level. **Denotes significance at the 5% level. ***Denotes significance at the 1% level

Appendix II – Distribuition of Φ

Distribuition of Φ

	No lagged changes			One lagged changes			Four lagged changes		
Obs	90%	95%	99%	90%	95%	99%	90%	95%	99%
				Panel A: TAR					
50	5.09	6.20	8.78	5.08	6.18	8.67	5.22	6.33	9.05
100	5.01	5.98	8.24	4.99	6.01	8.30	5.20	6.28	8.82
250	4.94	5.91	8.08	4.92	5.87	8.04	5.23	6.35	8.94
500	4.91	5.85	7.89	4.88	5.79	7.81	5.21	6.33	9.09
				Panel B: MTAR					
50	5.59	6.73	9.50	5.56	6.67	9.32	5.32	6.39	8.89
100	5.45	6.51	8.78	5.47	6.51	8.85	5.20	6.20	8.46
250	5.38	6.42	8.61	5.36	6.38	8.62	5.13	6.12	8.26
500	5.36	6.35	8.43	5.32	6.28	8.40	5.06	6.05	8.31

Table 14 - Enders and Siklos 2001 - Distribuition of Φ.

Appendix III – Indexes Data

DJIA	Freddie	SPX	STOXX	FTSE
2293.62	4.1142	294.87	844.24	2075
2440.06	5.1037	317.98	873.14	2151
2692.82	5.9786	349.15	943.57	2299.4
2753.2	7.9159	353.4	980.22	2422.7
2707.21	5.9161	339.94	965.38	2247.9
2880.69	5.8536	358.02	1006.62	2374.6
2452.48	6.5202	306.05	807.74	1990.2
2633.66	4.3225	330.22	835.34	2143.5
2913.86	4.0829	375.22	975.79	2456.5
2906.75	6.6556	371.16	984.84	2414.8
3016.77	6.8118	387.86	1026.61	2621.7
3168.83	8.645	417.09	1000	2493.1
3235.47	10.8531	403.69	1020.69	2440.1
3318.52	10.5094	408.14	1036.58	2521.2
3271.66	10.3125	417.8	984.9	2553
3301.11	10.2812	435.71	1057.56	2846.5
3435.11	12.0937	451.67	1129.45	2878.7
3516.08	12.4375	450.53	1164.87	2900
3555.12	13.75	458.93	1264.45	3037.5
3754.09	12.7812	466.45	1429.1	3418.4
3635.96	12.4062	445.77	1307.61	3086.4
3624.96	12.6875	444.27	1236.04	2919.2
3843.18	15.25	462.69	1265.38	3026.3
3834.44	13.2187	459.27	1298.78	3065.5
4157.69	12.5937	500.71	1279.41	3137.9
4556.09	15.0937	544.75	1343.59	3314.6
4789.08	17.2031	584.41	1434.58	3508.2
5117.12	17.2812	615.93	1538.23	3689.3
5587.14	20.6875	645.5	1591.05	3699.7
5654.62	22.4375	670.63	1621.99	3711
5882.16	21.5312	687.31	1682.84	3953.7
6448.26	24.7812	740.74	1850.1	4118.5
6583.47	28.0937	757.12	2116.57	4312.9
7672.79	27.75	885.14	2425.08	4604.6
7945.25	37.4375	947.28	2637.42	5244.2
7908.24	35.9375	970.43	2633.63	5135.54
8799.8	42.8125	1101.75	3229.29	5932.22
8952.01	48.9375	1133.84	3417.88	5832.55
7842.62	49.5	1017.01	2709.61	5064.36
9181.43	50.25	1229.23	3320.25	5882.58
9786.16	64.4375	1286.37	3566.53	6295.33
10970.81	57.5625	1372.71	3747.38	6318.53
10336.96	57.375	1282.71	3629.61	6029.84

11497.12	50.625	1469.25	4742.42	6930.2
10921.93	44.5	1498.58	5059.11	6540.22
10447.9	46.5	1454.6	4832.67	6312.71
10650.92	41.0625	1436.51	4780.34	6294.24
10786.85	53.8125	1320.28	4557.13	6222.46
9878.78	62.75	1160.33	4004.89	5633.73
10502.4	65.18	1224.42	4057.64	5642.5
8847.56	67.95	1040.94	3339.91	4903.39
10021.5	67.76	1148.08	3706.93	5217.35
10403.94	65.76	1147.39	3695.24	5271.76
9243.26	65.13	989.81	3060.91	4656.36
7591.93	59.3	815.28	2314.96	3721.75
8341.63	56.9	879.82	2407.51	3940.36
7992.13	61.48	848.18	2098.89	3613.28
8985.44	55.7	974.5	2395.47	4031.17
9275.06	53.5	995.97	2386.92	4091.31
10453.92	54.15	1111.92	2660.37	4476.87
10357.7	58.48	1126.21	2663.32	4385.67
10435.48	59.91	1140.84	2687.68	4464.07
10080.27	63.57	1114.58	2668.47	4570.77
10783.01	67.22	1211.92	2774.77	4814.3
10503.76	72.99	1180.59	2866.08	4894.37
10274.97	60.85	1191.33	3036.54	5113.16
10568.7	65.84	1228.81	3261.3	5477.71
10717.5	55.96	1248.29	3349.1	5618.76
11109.32	65.3	1294.83	3507.13	5964.57
11150.22	60	1270.2	3378.85	5833.42
11679.07	57.5	1335.85	3551.04	5960.81
12463.15	66.04	1418.3	3697.22	6220.81
12354.35	67.89	1420.86	3708.8	6308.03
13408.62	59.4	1503.35	3946.98	6607.9
13895.63	61.75	1526.75	3820.33	6466.79
13264.82	62.47	1468.36	3683.79	6456.91
12262.89	32.2	1322.7	3017.98	5702.11
11350.01	28.35	1280	2906.42	5625.9
10850.66	14.5	1166.36	2635.13	4902.45
8776.39	1.49	903.25	2083.9	4434.17
7608.92	0.73	797.87	1815.99	3926.14
8447	0.73	919.32	2098.28	4249.21
9712.28	0.65	1057.08	2453.88	5133.9
10428.05	1.66	1115.1	2585.33	5412.88
10856.63	1.47	1169.43	2629.16	5679.64
9774.02	1.26	1030.71	2359.66	4916.87
10788.05	0.375	1141.2	2482.18	5548.62
11577.51	0.3	1257.64	2586.46	5899.94
12319.73	0.325	1325.83	2582.9	5908.76
12414.34	0.3991	1320.64	2561.37	5945.71
10913.38	0.3565	1131.42	2159.7	5128.48

12217.56	0.227	1257.6	2369.52	5572.28
13212.04	0.225	1408.47	2458.62	5768.45
12880.09	0.295	1362.16	2380.99	5571.15
13437.13	0.251	1440.67	2518.19	5742.07
13104.14	0.26	1426.19	2577.62	5897.81
14578.54	0.2851	1569.19	2697.77	6411.74
14909.6	0.859	1606.28	2604.51	6215.47
15129.67	1.52	1681.55	2776.23	6462.22
16576.66	1.41	1848.36	2919.42	6749.09
16457.66	2.83	1872.34	2916.37	6598.37
16826.6	4.17	1960.23	3014.19	6743.94
17042.9	3.92	1972.29	3067.29	6622.72
17823.07	1.81	2058.9	3003.95	6566.09
17776.12	2.15	2067.89	3434.93	6773.04
17619.51	2.4	2063.11	3285.16	6520.98
16284.7	2.195	1920.03	2976.73	6061.61
17425.03	2.18	2043.94	3100.26	6242.32
17685.09	1.62	2059.74	2790.17	6174.9
17929.99	1.32	2098.86	2813.33	6504.33
18308.15	1.81	2168.27	2843.17	6899.33
19762.6	1.59	2238.83	3010.55	7142.83
20663.22	3.87	2362.72	3160.69	7322.92
21349.63	2.4	2423.41	3122.17	7312.72
22405.09	2.23	2519.36	3172.79	7372.76
24719.22	3.09	2673.61	3177.84	7687.77
24103.11	2.45	2640.87	2965.44	7056.61
24271.41	1.42	2718.37	3042.96	7636.93
26458.31	1.59	2913.98	3067.94	7510.2
23327.46	1.37	2506.85	2760.06	6728.13
25928.68	1.13	2834.4	3117.01	7279.19
26599.96	2.625	2941.76	3178.94	7425.63
26916.83	2.71	2976.74	3255.74	7408.21
28538.44	3.22	3230.78	3403.03	7542.44
21917.16	3.06	2584.59	2730.31	5671.96
25812.88	1.29	3100.29	2988.99	6169.74
27781.7	2.19	3363	2904.12	5866.1

Table 15 – Indexes - Data