The Investigation of the Dynamic Linkages between Real Estate Market and Stock Market in Greece

Dimitrios Gounopoulos[a], Kyriaki Kosmidou, Dimitrios Kousenidis, Victoria Patsika

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Abstract

We use quarterly data from Greece and investigate the dynamic linkages between the price of the real estate market and the price of the stock market focusing on two transmission mechanisms, namely the wealth and credit-price effects. The empirical analysis employs advanced methodological techniques and presents evidence supporting the existence of both the wealth effect and the credit effect in the long-run while in the short-run there is a one-way causal effect running from stock market towards house market. Results reveal asymmetric adjustment to equilibrium process and considerably stronger for positive deviations from the equilibrium.

Keywords: House prices, stock market, linear cointegration, wealth – credit effect

JEL Classification: G15 G32 C10

* Dimitrios Gounopoulos (d.gounopoulos@bath.ac.uk) is a Professor at the School of Management, University of Bath, Bath, BA2 7AY and a Senior Visiting Research Fellow at the University of Sussex, School of Business, Management and Economics, Falmer, Brighton BN1 9SL, UK; Kuriaki Kosmidou (kosmid@econ.auth.gr) is from the Department of Economics, Aristotel University of Thessaloniki, 54124 Thessaloniki, Greece, Dimitrios Kousenidis (dkous@econ.auth.gr) is the Head of the Department of Economics, Aristotel University of Thessaloniki, 54124 Thessaloniki, Greece. Victoria Patsika (victoria_patsika@hotmail.com) is from Southampton Business School, University of Southampton, Southampton, SO17 1BJ, UK. We are grateful to Chris Adcock (The Editor), Dimitris Andriosopoulos, Chimnoy Ghosh, Ranko Jelic, Anestis Ladas, Gianluca Marcato, Ekaterini Panopoulou, David Newton and seminar participants at Aristotel University of Thessaloniki, Athens University of Economics and Business, Newcastle University, the University of Sussex, the European Financial Management Association Conference the Financial Engineering and Banking Society Conference, for valuable comments and suggestions and to Chen Huang and George Loukopoulos for excellent research assistance

1. Introduction

Real Estate constitute one of the most important activities in world, bringing about substantial reallocations of resources within the economy. It has been only recently that the U.S., the largest economy in the world, elected as President Donald Trump, a Real Estate businessman and developer who has built, renovated, and managed numerous office towers, hotels, casinos, and golf courses in the country. In 2015, the total value of world real estate reached $217tn (£153tn) and is more than 12 times US GDP, or 21 times China's GDP. This is also equivalent to 36 times the total value of all the gold ever mined (approximately $6tn), 2.3 times the value of outstanding securitised debt ($94tn), and 3.9 times the total value of equities ($55tn).

It has not always been that great in the real estate industry. There were periods of crises with the most recent with global impact the subprime mortgage crisis that triggered by a large decline in home prices after the collapse of a housing bubble. A number of researchers have attempted to trace its root causes subprime mortgage crisis, Bhardwaj and Sengupta (2008), Mian and Sufi (2009), Keys, Mukherjee, Seru, and Vig (2010), Demyanyk and Van Hemert (2011), Dell'Ariccia, Igan, and Laeven (2012), Driessen and Van Hemmer (2012), Zhang et al., (2016) are only a few of the examples in this vast and growing literature. Crises in the real estate sector are not only caused due to endogenous characteristics as in the case of U.S. but due to exogenous features as occurred in Greece. In the Greek case there has been a "bubble" in the real estate market, culminating in the period 1999-2008. The total increase in value during this period reached 91%, while the corresponding increase in real GDP over the same period was considerably smaller. Since 2007, when the subprime mortgage crises erected and the Greek Financial Crises exploded the situation changed dramatically and turned to a sharp decline. The fall in house prices, cumulatively between the beginning of the crisis in 2008 and the current period represents a percentage higher than the 41.4%. The sharp drop in economic activity of the country caused serious reduction of income in society and contributed to increased uncertainty about the future. At the same time, another main cause of the fall of real estate was the imposed taxation which demotivated many potential buyers to invest in the industry.

During the ongoing Greek financial crisis, the country experienced as well collapse of the stock market prices. The general index in the capital market dropped from 5100 index points just prior the crises blast to 501.90 index points. The extreme reaction of the stock exchange in combination with the collapsing real estate market motivated us to explore if the relation between real estate market

performance and stock market returns has been examined in a downfall economy. Surprisingly, the relevant literature failed to provide evidence on the stock market performance during a deep period of financial distress. This raises several interesting questions: Is there a link between stock market prices and house prices in a country with deep financial crises? Are direct investment in commercial or residential real estate improves upon diversification benefits available in the share market? Is there evidence of asymmetric responses between the fluctuations of the two examined market price indices? Finally does the evidence support the wealth or the credit effect?

Many researchers have been interested in the real estate market and more specifically in its correlation with the stock market. Some of them claimed that these two markets are segmented (Okunev and Wilson, (1997); Garmaise and Moskovitz (2004)) and there is no correlation between these two while others believed that there exists a correlation due to the capital flows. Having such mixed results the investigation of any possible relationship between these two markets has become a matter of great importance by the end of the 20th century (Rajan and Zingales (2003)). Motivated by the conflicting empirical evidence on real estate and stock markets and the luck of any suggestion during periods of deep and lengthy crises, we address these questions and revisit the role of dynamic linkages. We use a large and comprehensive sample of Greek over the period from 1994 to 2015.

We find linear evidence supporting the existence of a long-run causal linkage between the prices of the two markets. Specifically, Johansen's method detected evidence supporting and the "credit effect" in the long-run; in the short-run, only a one-way causal effect running from stock market towards house market has been found.

This study makes important contributions to the real estate and stock market literature. First, it provides new evidence on the existence of causation and the causal direction of the linkages between price indices of the real estate and the stock markets especially in an occasion that this ascertainment holds even more tentatively for the Greek case. Second, this study employs the asymmetric cointegration methodology making further steps regarding the nonlinear framework to investigate the potential asymmetric relationship between the stock market prices and the house market prices. In particular, the asymmetric Autoregressive Distributed Lag (ARDL) cointegration technique is deployed, to test for a possible nonlinear relationship between the stock market prices and the house market prices. Third, our study attempts to detect possible asymmetries in the adjustment process to equilibrium. Besides, the

investigated period comprises performances of both strength and weakness for the two markets coinciding with the periods before and after the beginning of the crisis.

The majority of the research on stock market and house market prices modeling has been conducted in a linear framework. Actually, the majority of the models adopted in the prior empirical studies addressing the issue of equilibrium have generally failed to take into account possible non-linear properties of the adjustment process. As noted by Laxton et al. (1993), both bias and mistakes are increasingly likely when a linear and symmetrical methodology is adopted to test economic variables that are non-linear and asymmetric. However, many macroeconomic variables incorporate nonlinear properties, especially in the area of business cycles (Neftci (1984); Falk (1986)). As both stock and house market prices are driven by the economic activity they could also be expected to exhibit nonlinearities. This possibly implies that linear models may not be appropriate to explore the determinants of both markets prices and could provide misleading evidence. More specifically, in the presence of nonlinearities, the response of the examined markets to positive shocks in the economy's price level may be different from the response to negative shocks.

Our study is related to the work of Ibbotson and Siegel (1984), Gyourko and Keim (1992), Quan and Titman (1997), Miao et al., (2011), Driessen and Van Hemert (2012), Heaney and Srianantha kumar (2012), Alimov (2016) and Jang (2017). Ibbotson and Siegel (1984), Gyourko and Keim (1992), Quan and Titman (1997) empirically examine the relationship between real estate prices and stock market return. We update their work using a comprehensive sample of real estate investment, as well as by considering specific extreme characteristics, and offer new evidence. Alimov (2016) exploits shocks to the value of real estate collateral to study how exogenous changes in firms' external financing capacity affect their competitive performance and industry dynamics. We extend his work by examining the shock to the values of the real estate - stock markets as a result of the exogenous impact of the country's financial crisis. Furthermore, we extend the work of Driessen and Van Hemert (2012) on the pricing of commercial real estate securities and show that market temporarily and in stages reacts to price pressures caused by a major and lengthy financial crises. Overall, contrary to earlier studies, the findings of this paper are consistent with the predictions of the theoretical model of Markowitz (1952) when applied in the context of Real Estate and Stock Markets.

The rest of the paper is organized as follows. Section 2 provides a literature review on the relationship between the real estate and the stock market and section 3 provides the research hypotheses.

Section 4 describes our sample. Section 5 briefly presents the background of the adopted empirical methodology. Section 6 illustrates the results of the empirical analysis. Finally, section 7 summarizes and concludes.

2. Literature Review

A. Theoretical Framework

There are two significant theoretical views in explaining the relationship between stock and real estate price. Firstly, the well-known wealth effect, which stresses a transmission channel from stock to real estate (Okunev and Wilson, 1997; Okunev et al., (2000)). When stock prices rise, the share of households' portfolios in the stock market will rise, and households will have a desire to rebalance their portfolios by selling shares and buying other assets (Markowitz (1952). Hence, it indicates the stock market lead the property market. Most studies discovered that wealth effect on aggregate consumption and prices is relatively weak (Fama (1981), Fischer and Merton (1984), Barro (1990), Poterba and Samwick (1995)).

Secondly, it is the credit-price effects, which supports the view that the property market will lead the stock market. Rising real estate prices can stimulate economic activity and by raising the value of collateral, reduce the cost of borrowing and increase the availability of finance for both firms and households. Firms that hold a certain amount of real estate or land have huge unrealized capital gains and thus has a stronger balance sheet position. In such a case, the expected profits from realizing capital gains and the expected revenues from investment will lead investors to bid up the equity value of the firm (Kapopoulos and Siokis (2005)). Since firms demand more land and buildings to carry out expanded investment, the prices of commercial as well as residential property rise. Therefore, the interaction between these two assets markets will lead to a complementation in price influences for each other's.

B. Linkages between Real Estate Market and Stock Market

A considerable number of research efforts on the relationship between the real estate market and the stock market have supported both theoretical and empirical evidence that the two markets are completely unrelated while another strand of studies have established a cointegration relationship, between them. For instance, Liu et al. (1990) and Geltner (1990) found evidence of market segmentation

between real estate and stock markets when using appraisal based returns. Conversely, studies by Ambrose et al. (1992) and Gyourko and Keim (1992) documented opposite results. Ambrose et al. (1992) indicate that mortgage and equity real estate investments trusts (REITs) display similar return generating characteristics to the stock market and they highlight that the stock markets and real estate are integrated. Further relevant literature at REITs look their relationship with stock markets and their sensitivity to interest rates as far as the credit effect is concerned (i.e Stevenson et al (2007). Chaney and Hoesli (2010), Lean and Smyth (2012), Akimov et al., (2015)). The studies indicate interest rate sensitivity and the impact of interest rates on property companies, in relation to both returns and volatility

Academic research in the United States suggests that real estate returns and stock returns are not only highly uncorrelated but also the relation may be negative. Using annual U.S. data from 1947 to 1982, Ibbotson and Siegel (1984) found real estate's correlation with S&P 500 Index stocks to be -0.06. Worzala and Vandell (1995), using the Frank Russell Index and quarterly data from 1980 to 1991, estimated the correlation to be -0.0971. Geltner (1993), applying a "desmoothing" procedure that alters the volatility of the real estate return index, reported a correlation of 0.3.

Evidence from other countries indicates a somewhat closer relation between stocks and real estate. Lim and Ong (1992), using an index based on quarterly transactions, estimated the correlation for Singapore to be 0.43. Worzala and Vandell (1995) estimated the correlation of returns on U.K. real estate with stock returns to be 0.039. Stone and Ziemba (1993) documented a strong relationship between Japanese land prices and stock market performance, but their study did not include commercial investment- grade properties. Green (2002) examines the largest state of U.S. California and documents that households have high incomes in comparison to other states and therefore are more likely to hold relatively large amounts of stock. Surprisingly, Northern California results reflect rising expectations about the national economy in general, which can be reflected in both stock and house prices. Findings indicate that Northern part is roughly three times more likely to have behavior influenced by stock performance than are homebuyers in Southern California. Further Kakes and Van Den End (2004) reveal that housing market is also driven by other factors such as changes in interest rates, economic growth, mortgage lending criteria and housing supply conditions.

Liu et al., (1990) investigates whether the commercial real estate market is segmented from the stock market. Evidence is found that segmentation does exist as the result of indirect barriers such as the cost, amount, and quality of information for real estate rather than legal constraints. However, this

evidence is contingent on whether real estate returns are computed with appraised values or imputed sale prices and on which market proxy is chosen. However, the researchers acknowledge that segmentation exists between stock and real estate markets with the market proxy chosen and the sorting procedure used, influencing whether segmentation arises due to indirect constraints or legal barriers.

Quan and Titman (1997) studied the linkage between the stock returns and the real estate market values for 17 countries. In the majority of the examined countries, the results were in favor of a strong positive relationship between the two markets, establishing the relationship with both time series and cross-sectional data sets. It appears that previous-period stock return are a dominant factor in determining this period's real estate price changes. Their evidence indicates that the positive relation is mainly attributable to countries in the Asia/Pacific region, although the relation between stock and real estate prices in selected European countries is also positive. There also appears to be a strong relationship between changes in real estate income and current and past period stock returns.

Okunev et al. (2000), in their study on the American property supported that linear causality tests produce a spurious causal relationship running from the housing market to the stock market. Non-linear tests, on the other hand, validated a bidirectional linkage between the stock market and the real estate market. Later study by Liow (2006) used the ARDL methodology to examine the relationship between the stock and the property market. He was able to establish a two-way long-run relationship between the real estate and the stock market in Singapore. Furthermore, he also found that the residential house prices impact the stock market prices more intensely, in the short run. Further Li and Lee (2010) considered a non-linear relationship between the real estate market and the stock market in Japan and applied the Threshold Error Correction Model (TECM). Their findings suggested that, in both the short and long-term period, the stock market and real estate market seem correlated.

Sutton (2002) examined the extent to which house price fluctuations in six advanced economies can be attributed to fluctuations in national incomes, interest rates and stock prices. The main empirical finding is that favourable economic developments captured by these variables appear to have played an important role in house price gains, although in some instances prices appear to have increased by more than warranted by the set of fundamental determinants considered. Sutton reveal that decline in share values might foreshadow some downward pressure on house prices, although the precise amount cannot be established.

Heaney and Sriananthakumar (2012) in an Australian context document that direct investments in commercial or residential real estate provide valuable diversification benefits for investors. They do not report similar evidence for indirect real estate investment vehicles like listed real estate investment trusts. Further, analysis of real estate and share market suggest that the correlation between real estate returns and share market returns is time-varying. Additionally, while all of the asset class coefficients increased with the Global Financial Crisis period this broad movement in asset class correlation is not evident in during the Wall Street Crash of 1987.

China's real estate market is one of the biggest recipients of foreign direct investment at global level. The rapid real estate appreciation as it has been conveyed over the last decade has caused in several occasions concerns about real estate bubble. The monthly real estate price index shows price decline or stagnation for all major cities since around 2010. On the other hand, China's stock market is soaring, Shanghai composite index rose from around 2000 in June, 2014. Wang et al. (2016) highlight that the stock rally is potentially created by switching of momentum from direct real estate to stock market and also by pure speculation. They show that investors could diversify investment by investing in both direct real estate and general stock market, however, real estate equity brings little if any diversification. The stock market movement seems to deviate from its fundamentals.

C. Evidence from Greece

According to the Bank of Greece (2002), the number of active trading accounts in the Athens Stock Exchange rose from 355 000 in 1998 to 145 900 in 1999 and 1,792,000 in 2001. The total value of stocks held by households as per cent to the total disposable income increased from 8.5% in 1995 to 68.5% in 1999 and 40.8% in 2001. Even during this period that the stock market was at its peak and households sold property in order to take advantage of the rise, the rate of growth of house prices fell only sluggishly from 14.4% in 1998 to 8.9% in 1999 (Bank of Greece, 2008). Kapopoulos and Siokis (2005) argue that higher stock prices increase the share of households' portfolios in the stock market and cause a rebalancing of their portfolios by selling stocks and purchasing other assets like houses.

Gounopoulos et al. (2012) attempted to determine the main components of the house prices in Greece. The results showed that the latest house price increase in the country could be adequately explained by the stock market index as well as by inflation, interest rates and the production index. Furthermore, construction costs and long-term interest rates negatively affect stock market performance.

By contrast, equity prices are positively affected by wages, production-excluding-construction and the presence of the informal sector. The latter constitutes evidence that the underground economy in general and funds realized via tax evasion eventually find their way to the Greek stock market. The study identifies a fundamental shift in the behaviour of Greek homeowners, who appear to be moving away from the treatment of housing as consumption good, towards treating house purchases as investment. Greek case has unique characteristics as Greece retains a traditional position as the eurozone country with the lowest rate of homeownership through mortgage or other loans, at just 13.9 percent, with Italy on 15.9 percent, Cyprus on 20.4 percent and the eurozone average at 27.9 percent.

Overall, prior evidence on the relationship between real estate market and stock market is unclear as many studies have supported that the two markets are completely unrelated while on the other hand there are evidence which emphatically highlight that the stock markets and real estate are integrated.

3. Hypotheses Development

The nature and the direction of the causal relationship between house and stock prices is important to be determined in order to detect possible wealth and/or credit effects that are of major importance to practitioners, analysts and policy makers. More particularly, both assets are considered as investment alternatives, with housing being also considered as a consumption good. Regarding a wealth effect, it would imply causality running from the stock market to the housing market. It is expected that a gain in stock prices may lead to an increase in the relative share of stocks in an investment portfolio and wealth this might motivate households to invest in or consume more housing thus rebalancing their portfolios.

H1: Increase in the stock price will cause an increase in the real estate prices as an outcome of the wealth effect.

Over the period of our study Greece has experience an unpresented period of deep debt financial crises which is on constant development. The GDP of the country has fallen from $354 billion in 2008 to $179 billion in 2016, the Stock Exchange general index has dropped from 3,985 points in April 2008 to 682 in December 2016 (i.e. see Appendix D) while the real estate general index was reduced from 260.8 to 150.3 in August 2016 (i.e. see Appendix C). All previous studies have addressed the issue of markets growth but none did address what happens in the case of prices decline.

In this study we define the "deficiency effect" mechanism which implies that a drop-in stock prices will have an impact in real estate prices and the transmission flow from the stock market to the real estate market. It might be expected that households with unanticipated loss in share prices to decrease their ability to invest in houses or lose their ability to retain ownership in property with consequence to affect the real estate prices. However, housing and land are consumption as well as investment goods, so the relationship between stock and real estate prices could be stronger. We investigate whether the "deficiency effect" is likely to exist in Greek market, since the country has experienced big busts over the last decade.

H2: During periods of crises decrease in the stock price will impact the real estate prices

On the other hand, rising house prices may act as a collateral to credit-constrained household and firms and lead to an increase in consumption and investment from households and firms, respectively. Chaney (2012) provide support to this angle and documents that shocks to the value of real estate can have a large impact on aggregate investment. An appreciation in the value of a firm's real estate by one dollar will cause investment increase by 0.06 cents. Corradin and Popov (2015) concentrates on new business creation and report that households with higher home equity today are significantly more likely to own and operate a business in the future. On the entrepreneurial side Schmalz et al (2017) highlight a channel through which house prices can affect aggregate activity and show that collateral frictions are a significant determinant of the creation of new firms. Following prior evidence, we believe that an increase in house prices may ultimately lead to firms creation and an increase in stock prices as homeowners would desire to create a diversified portfolio of investment. In turn this may fuel a wealth effect arising from higher stock prices and an upwards price spiral for both stocks and housing could occur. In sum, the wealth effect is identified when causality runs from the stock market towards the real estate while the credit effect implies the exact opposite direction of causality, that is, from the real estate market to the stock market.

H3: Rising house prices improve business conditions and contribute to business creation and stock prices appreciation.

A theoretical interpretation of the relationship between stock and real estate prices is the so-called persistent effect (i.e. explores the origins of the effect by focusing on investment in capital). Schmalz et al., (2017) shows that declining house prices also negatively affect the supply of entrepreneurs, which may, in turn, decrease aggregate activity. Mian et al., (2013) reveal that declining house prices impair the balance sheet of levered households, thus contributing significantly to a decline in employment. They indicate three channels through which the change in housing wealth might affect household spending. The first channel is the direct ‘‘wealth effect.’’ The second is the indirect effect given the dramatic decline in spending, nontradable employment is disproportionately affected. This knock-on effect on local nonreadable employment further depresses local spending.

Further, housing net worth serves as collateral for access to credit; a decline in housing can force homeowers to cut back spending due to credit constraints. Declining real estate prices can stimulate economic activity and, by reducing the value of collateral, increase the cost of borrowing and decrease the availability of finance for both firms and households. Firms that hold a certain amount of real estate or land have capital losses and thus has a weaker balance sheet position. In such a case, the expected losses from realizing capital deficit and the lack of expected revenues from investment will lead investors to weaken their position and bid down the equity value of the firm.

Negative circumstances will drive firms to reduce demand on land and buildings as they are not willing to carry out any investment, the prices of commercial as well as residential property fall. Thus, the interaction of these two asset markets leads to a spiraling downturn in both prices and explains why an exogenous shock causes persistent effect.

H4: Declining house prices will have a negative impact in the stock prices

This study aims at detecting possible wealth and credit, deficiency and persistent effects in Greece. In this context, we further explore the long-run and short-run dynamics between house prices and stock market prices. Given that the results of the previous studies are rather mixed on the wealth and credit effects it is important to explore whether the different results came out because of different research approaches. In addition, taking into consideration that no research effort have explored the deficiency and persistent effects, we attempt to enrich the relevant literature by employing Greek data.

4. Data and Methodology

The period under examination coincides with a period of substantial growth realized by the Greek economy 1997Q1 to 2008Q2, and a deep financial crises 2008Q3 to 2015Q2 where the Greek economy due to the debt crisis is experiencing an abrupt reversal in its long-term cycle. We collected data on the real estate price index, the unemployment rate, the long-run interest rate, the short-run interest rate, the Athens stock exchange general index and the total production index excluding construction. The Consumer Price Index (CPI) data were used to transform nominal variables into real. Furthermore, we collected data on the construction cost index, the labour force participation rate and the wage rate. All data were gathered from the same database, Organization for Economic Co-operation and Development (OECD) statistics. The set of data used are quarterly observations for the House Price Index proxied by the index of prices of Dwellings (Urban Areas, 1997=100) and the Athens General Stock Market Index, running from the 1st quarter of 1997 until the 2nd quarter of 2015.

We extracted stock market data from the daily press, ASE reports (History of ASE, Fact Books, Annual and Monthly Statistical Bulletins) and Annual Reports of the Hellenic Capital Market Commission (HCMC). Other additional information about the stock market comes from databases available at Compustat, Datastream and Thomson Financial Securities Data Corporation, at the public libraries of ASE and the HCMC, the library of the Bank of Greece and the database of the Greek Parliament. Table 1 offers some valuable financial data on the Greek Economy.

[Please Insert Table 1 about Here]

Figures 1 and 2 below, present the evolution of the Greece's housing price and the stock market price index over the examined time period. From a simple inspection of the above graphs, we notice that regarding the house prices there is a clear upward inclination till the beginning of the financial crisis in 2008 followed by a sharp declining trend till recently. As far as it concerns the evolution of the stock market prices, it is characterized by strong peaks at the end of 1999 and 2007 respectively and a sharp decline after 2008 coinciding with the beginning of the crisis. The prices of stock market had a smooth recover over the period 2012-2014 but since after they had a decline to the lowest ever level.

[Please Insert Figures 1 & 2 about Here]

4.1 The ARDL cointegration method.

The ARDL cointegration method employed in this paper, originally introduced by Pesaran and Shin (1999) and later extended by Pesaran et al. (2001) has many advantages compared to other cointegration methods. Firstly, the ARDL approach to cointegration performs better in small samples, Romilly et al. (2001). Secondly, it has the additional advantage that it can be applied irrespective of whether the variables under examination have been pretested to confirm that are integrated of order one [I(1)], thus allowing for statistical inferences on long-run estimates, which are not possible under alternative cointegration techniques. However, the ARDL cointegration technique is not valid in the presence of I(2) variables. The cointegration testing procedure for two-time series y_t and x_t, in the first step involves estimating the unrestricted error correction version of an autoregressive distributed lag (ARDL) model:

$$\Delta y_t = a_0 + \rho y_{t-1} + \theta x_{t-1} + \gamma z_t + \sum_{j=1}^{p-1} a_j \Delta y_{t-j} + \sum_{j=0}^{q-1} \pi_j \Delta x_{t-j} + e_t \quad (1)$$

Where z_t is a vector of deterministic regressors (trends, seasonals, and other exogenous influences, with fixed lags) and υ_t is an *iid* stochastic process. The lag length selection of the first-differenced variables is based on Akaike (1981) information Criterion (AIC), Schwarz Bayesian Criterion (SBC) and others.

Under the null hypothesis (i.e., y_t and x_t are not cointegrated), the coefficients of the lagged levels of those two variables in Equation (1) are jointly zero ($\rho=\theta=0$). Pesaran et al. (2001) showed that the assumption of no cointegration can be tested either by means of a modified F-test, denominated F_{PSS} or (for the cases that certain classical assumptions are violated) by means of a Wald-test, denominated W_{PSS}. The test procedure relies on two critical bounds; the upper and the lower one. If the empirical values of the F_{PSS}, the W_{PSS} statistics exceed the upper bound, the null is rejected (there is evidence of a long-run equilibrium relationship between y_t and x_t); if they lie below the lower bound, y_t and x_t are not cointegrated; if they lie between the critical bounds the test is inconclusive.

Alternatively, the null hypothesis of no cointegration can be assessed by means of the t_{BDM} test (Banerjee et al. (1998)) suitable for testing $\rho=0$ (no cointegration) against $\rho<0$ (cointegration). The t_{BDM} test also relies on two critical bounds (the upper and the lower one). If the empirical value of t_{BDM} statistic exceeds the upper bound, the null is rejected; if it lies below the lower bound, the null is not rejected; if it lies between the bounds the test is inconclusive.

4.2 Enders and Siklos Cointegration method.

Enders and Granger (1998) have shown that all tests for unit roots and cointegration have low power in the presence of asymmetries. Enders and Granger (1998) and Enders and Siklos (2001) have developed two different nonlinear cointegration models, which allow for tests of asymmetries, the threshold autoregressive (TAR) and the momentum threshold autoregressive (MTAR). TAR model can be described by the following equation:

$$\Delta\mu_t = I_t\rho_1\mu_{t-1} + (1-I_t)\rho_2\mu_{t-1} + \sum_{i=1}^{p-1}\gamma_i\Delta\mu_{t-1} + \varepsilon_t$$

$$\text{where} \quad \varepsilon_t \sim iid(0,\sigma^2) \qquad (2)$$

μ_t are the residuals of the cointegration equation, the lagged values of $\Delta\mu$ are meant to yield uncorrelated residuals and I_t is the heaviside indicator such that $I_t = 1$ if $\mu_{t-1}>\tau$ and zero otherwise.
The MTAR model is given by the equation:

$$\Delta\mu_t = I_t\rho_1\Delta\mu_{t-1} + (1-I_t)\rho_2\Delta\mu_{t-1} + \sum_{i=1}^{p-1}\gamma_i\Delta\mu_{t-1} + \varepsilon_t$$

$$\text{where} \quad \varepsilon_t \sim iid(0,\sigma^2) \qquad (3)$$

and $I_t = 1$ if $\Delta\mu_{t-1}>\tau$ and zero otherwise. Consistent estimates of the threshold τ are obtained using Chan's (1993) method. The coefficients ρ_1 and ρ_2 represent the different speeds of adjustment for the deviations from the long-run equilibrium. In both models, the null hypothesis of no cointegration can be tested by the restriction $\rho_1=\rho_2=0$ using an F-test. These F-statistics have a nonstandard distribution. Enders and Siklos (2001) have tabulated the appropriate critical values for both TAR and MTAR specifications. In addition, if a cointegration relationship exists, the null hypothesis of symmetric adjustment ($\rho_1=\rho_2$) can be tested by applying a standard F-test. As the Granger theorem guarantees, when the null hypothesis of no cointegration relationship is rejected an error correction model exists. Thus, if a cointegration relationship with MTAR adjustment exists, the following asymmetric error correction model can be estimated:

$$\Delta y_t = a + \beta_1 \mathrm{I}_t\Delta\mu_{t-1} + \beta_2(1-\mathrm{I}_t)\Delta\mu_{t-1} + \gamma_i\Delta y_{t-i} + \delta_j\Delta\chi_{t-j} + e_{1t} \qquad (4)$$

$$\Delta\chi_t = a + \beta_1 \mathrm{I}_t\Delta\mu_{t-1} + \beta_2(1-\mathrm{I}_t)\Delta\mu_{t-1} + \gamma_i\Delta y_{t-i} + \delta_j\Delta\chi_{t-j} + e_{2t} \qquad (5)$$

The ARDL approach to cointegration has several interesting characteristics. First, it performs better to small samples compared to alternative multivariate cointegration procedures. Second, it is more efficient than the standard Engle and Granger two step approach (typically employed in estimating asymmetric EC and TVEC models). Third, it does not require the restrictive assumption that all series are integrated of the same order allowing for the inclusion of both I(0) and I(1) (but not I(2)) time series in a long-run relationship; this not only provides considerable flexibility but it also avoids potential "pre-test bias", that means, specification of a long-run model on the basis of I(1) variables only (e.g. Pesaran et al. (2001); Romilly et al., (2001)). The combination of stochastic repressors' in the standard ARDL approach is linear, implying symmetric adjustments in the long- and the short-run.

5. Empirical Findings

In the first step of the empirical analysis, we explore the integration properties of the two variables involved, to ensure that the variables are not I(2). In the presence of I(2) variables the computed F-statistics from the ARDL model are not valid. At the first step, in the context of the empirical analysis, it is necessary to test for the integration properties of the involved series to avoid spurious statistical inference. Thus, we examine the variables for stationarity, by applying the Dickey-Fuller (1979) unit root test (ADF) and the more powerful DF-GLS test of Elliott, Rothenberg and Stock (1996). The appropriate lag length for each test is selected based on Akaike information criterion (AIC). The empirical results from both tests are shown in Table 2 and complementary indicate that both series are integrated of order one I(0).

The results, reported in Table 2, suggest that all variables are nonstationary in levels while, they turn stationary in first differences and thus they can be described as integrated of order one, I(1).

[Please Insert Table 2 about Here]

Thus, in the next step of our analysis we can proceed with testing for cointegration between the log of stock market price index and that of the house market in the bivariate context. Actually, we proceed by applying two alternative approaches; the ML Johansen's (Johansen (1990), (Pesaran & Shin 1999)) cointegration technique and the single equation cointegration method of Pesaran and Shin (1999) known as ARDL.

The former approach provides two likelihood tests for the detection of the number of cointegration vectors, namely, the trace test and the maximum eigenvalue test. The respective results from Johansen's testing methodology are reported in Table 3, below. More specifically, both the rank and the maximum eigenvalue tests suggest rejection of the null of no cointegration at the 5% significance level.

[Please Insert Table 3 about Here]

Having confirmed existence of cointegration that is a long run equilibrium relationship between the two examined market prices, in table 4 we present the long run coefficients and the estimates of the corresponding error correction models to determine the direction of the long run causal effect between them along with their short run dynamics.

[Please Insert Table 4 about Here]

Based on the estimated error correction terms, there is evidence of a unidirectional causal effect running from LHP towards LSP. In particular only the first error correction term in the model with DLSP as dependent variable, is negative (-0.14) and statistically significant at the 5% (t=2.45). Furthermore, the reported long run coefficients indicate that a 1% change of house prices leads stock prices to change by nearly 0.59%.

As the observation for hot and cold period are near to the permitted level we repeat the testing by following the bootstrapping method. Bootstrapping is a computational nonparametric technique which will enable us to draw a conclusion about the characteristics of a population strictly from the existing sample rather than by making parametric assumptions about the estimator. By applying bootstrapping, we multiply the observations to a safe level and we are able to see that our initial results remain strong and unchanged

Further, on Table 5 we report the findings from Granger causality test for possible short run causal effects between the examined series. The results support evidence of weak causality (p-value 0.083), running from DLHP on DLSP while on the opposite direction there is complete absence of any causal effect (p-value=0.418).

[Please Insert Table 5 about Here]

Next, the study proceeds with testings for cointegration by applying the ARDL method. We test for the presence of a long-run causal relationship by estimating the equations (6) and (7) below. In both

equations, we test for the joint significance of the coefficients of the lagged level variables. The null hypothesis indicates they are jointly zero (H_0: $\delta_1=\delta_2$ and H_0: $\delta_3=\delta_4$) suggesting that no long-run causal relationship exists between them.

$$\Delta \ln HP = a_0 + \sum_{i=1}^{p} b_i \Delta \ln HP_{t-1} + \sum_{i=0}^{q} c_i \Delta \ln SP_{t-1} + \delta_1 \ln HP_{t-1} + \delta_2 \ln SP_{t-1} + \lambda_1 D_1 + \varepsilon_{1,t} \quad (6)$$

$$\Delta \ln SP = \beta_0 + \sum_{i=1}^{p} d_i \Delta \ln HP_{t-1} + \sum_{i=0}^{q} e_i \Delta \ln SP_{t-1} + \delta_3 \ln HP_{t-1} + \delta_4 \ln SP_{t-1} + \lambda_2 D_2 + \varepsilon_{2,t} \quad (7)$$

The estimated specifications include properly constructed dummy variables (D_1 and D_2) to capture the effect of extreme values in the evolution of the two price indices. The optimal lag structure of the above models is chosen based on the AIC and the results derived from the bounds test are presented in Table 6.

[Please Insert Table 6 about Here]

Regarding the first model, with dependent variable the logarithm of the house prices, the reported F-value is 9.22 and is higher than the upper bound critical value at the 95% confidence level (4.16); while, when the logarithm of the stock market is the dependent variable, the calculated F-statistic is 4.15 and is also higher than the upper bound critical value at 90% confidence level (3.51) and marginally equal to the 95% (4.16). The results from both models reveal that there exists a bidirectional long-run causal relationship between house prices and stock market prices.

Next we present the estimates of the restricted error correction models and the long run coefficients. Starting from the model with dependent variable the DLHP, we can see in Table 7 - Panel A, that the error correction term is negative (-0.04) and statistically significant (p-value<0.001), indicating that there is long run causality running from LSP to LHP. In regards with the long run coefficients, we can see from the lower panel of the table that a 1% change of LSP causes LHP to change by nearly 0.4%.

[Please Insert Table 7 about Here]

The overall evidence from the above estimated ARDL structures reveal a long-run causal effect from the stock market to the housing price confirming a “wealth effect”. Once we turn to the model with

dependent variable the DLSP, presented in Table 7 - Panel B, the error correction term is negative (-0.189) and statistically significant (p-value<0.001), indicating that there is also long run causality running from LHP to LSP. However, there is not short run causality since lagged DLHP does not exert significant impacts on DLHP (p-value=0.629).

All the findings from the implied ARDL structure reveal a significant long-run causal effect from the housing price to the stock market confirming also a "credit effect". Thus, by means of two alternative, linear cointegration techniques, we document evidence of a bi-directional, long run, causal relationship between the Greek stock and house market prices revealing that both "wealth" and "credit effect" hypotheses hold.

However, the existence of no linearity in economic and financial time series is a normality necessitating the survey of its validity. The linear models do present an ease in the interpretation of the results that they offer, since they simply suggest that any observation can be explained in terms of a linear combination of past observations plus an error term, with a given variance, while forecasts (and their margins of error) are just as easily estimated. On the other hand, few economic phenomena can be described adequately with the use of linear models. Evidence in literature argues that asymmetry, time irreversibility, sudden bursts of great amplitude of prices (at irregular time epoch - intervals) cannot be captured by linear models.

Thus, having detected the presence of cointegration in the linear framework we proceed our analysis under the nonlinear cointegration framework and more particularly focusing at discovering possible hidden information due to asymmetric adjustments to the long-run equilibrium. Towards this direction, following Enders and Siklos (2001), we estimate the TAR and the MTAR pacifications and then test for cointegration and asymmetry. In particular, we test the null hypothesis of no cointegration, $H0:\rho1= \rho2=0$ and that of symmetry, $H0:\rho1= \rho2$.

[Please Insert Table 8 about Here]

The results, reported in Table 8 show that in both models, the null hypothesis of no cointegration can be rejected since the F-joint for the TAR and MTAR models are 10.624 and 11.778, respectively. We observe that F-joint for TAR and MTAR are larger than the critical values which are 5.927 and 6.283. The results from the TAR model suggest that the null hypothesis of symmetry cannot be rejected (F-statistic =

3.22). However, considering that the speed of adjustment depends on the previous period's change (MTAR model), the results imply that the null hypothesis of a symmetric adjustment towards the long-run equilibrium could now be rejected at the 5% significance level (F-statistic = 11.77). Besides, the results from the MTAR model further reveal that the adjustment process is considerably stronger for positive deviations from the equilibrium, with the point estimate of the threshold equal to 0.045. Since there is no presumption on the use of the TAR or the MTAR model, the recommendation is to choose the best adjustment mechanism using a model-selection criterion such as the AIC or Schwarz information criterion. For our analysis, both criterions favored the MTAR specification.

6. Robustness Checks

The main conclusion of this study is the existence of wealth effect in both short-and long run and credit effect in the long-run. In this section, we address the robustness of our novel evidence. The main robustness question concerns the Greek Financial Crises during which both the Stock and Real Estate market experienced a severe downfall.

A. Market Conditions

Specifically, one can argue that everything may be different under extreme circumstances as a deep and lengthy financial crisis that Greece is experiencing since 2010 and the impact that it has in the economic life of the whole nation. Further the results may differentiate during hot periods that can be associated with real estate bubble or stock market frenzy. To address those issues, we provide a new set of tests which accounts for those two different states of the economy.

The results indicate that in both periods the wealth and the credit effect hold their position but their significant appear to be stronger in the crises period. This refers to properties loosing large part of their value and stock prices collapsing. In this case the falling real estate prices affect the prices of the companies in the stock exchange and vice versa the lowering prices in the stock market reduces the amount that can be invested in the property market.

Practically, the wealth effect refers to the psychological effect of asset value increases, such as those experienced during a bull market, on spending patterns. The concept focuses on how the feelings of security, referred to as consumer confidence, bolstered by the rising value of assets, such as investment portfolios and real estate, lead to higher levels of spending, correlating with lower levels of saving. These

changes are said to be seen regardless of changes in discretionary income, in either a positive or negative direction.

B. Other Sensitivity Tests

To further control for the validity of our results we proceed and perform numerous additional testing's. The long-run cointegrating relations were tested with a modification of the general VAR model, called the Johansen's Vector Error Correction model. By using the nonstationary price series, the Johansen's test captures the number of cointegrating vectors between the variables. In addition, the robustness of the cointegrating vectors can be tested with restrictions on the coefficients of the error correction model. The short-run dynamics are inspected with return series using multivariate Granger-causality tests. In addition, impulse response and forecast error variance decomposition analyses are incorporated for robustness checks of the results. The results are unchanged when those modifications and alternative techniques are implemented.

Overall, the findings from our event study support our interpretation that during periods of crises decrease in the stock price will impact the real estate prices creating deficiency effect as well as declining house prices will have a negative impact in the stock prices causing persistent effect, i.e., investors are reluctant to invest their money and focus only on the most promising opportunities.

C. Impulse Response

We plot the 20-month impulse response functions of the stock price and the house price levels, under different shocks. Initially, a shock to the house price leads to an increase of the stock prices for three periods and the continues with a decline which lengths until the 16^{th} period. Then the reaction turns negative which is an unfortunate situation. Further, a positive shock to the stock price induces a strong positive effect on the house prices of Greece for 12 periods until it stabilizes. This result indicates the large impact that stock markets have in the houses prices in Greece as many investors took advantage of profits and invested them on properties. Another attractive finding shows that a shock to the stock prices lowers the price index dramatically. Finally, there is almost no response of the house price market. price to a shock in the same market.

[Please Insert Figures 3 about Here]

D. Variance Decomposition

The second standard tool to analyze the properties of the estimated structural VAR is the variance decomposition We first examine the variance decomposition of the stock price, which shows that it depends mainly on itself (over 91 percent), across all periods. The variance of the house price explained by the stock price increases over the time and reaches above 50% after the 12th period. This is an indication of the great dependence of the house market in the stock exchange performance. In addition, the variance of the house price that can be attributed to itself, demonstrates a dramatic fall over the periods that follow. The variance of the stock price level that is explained by the house price has a smooth move around 10%, which shows that house market does not have any impact in the stock market.

[Please Insert Figures 4 about Here]

7. Discussion

7.1 Why the one-way causal effect turn to double in the long term

A natural question that arises from our findings is why in the short term there is a one-way causal effect (i.e. from stock market towards house market) and in the long term it exists both wealth effect and credit effect. We argue that money placed in the housing market remain invested for many years and liquidation can take place only in the long term. On the other hand stock exchange is a volatile market where funds can be withdrawn at any time.

First consumers that select to position themselves in the real estate market will not react with stock market investments in the short term but they would wait until wealth will be realized on their property. Bank of England Ex-Governor Mervyn King, stated that the value of a house is simply the present value of the housing services it delivers in the future. Those who have more housing than they plan on consuming in the future (those who are net "long" housing) will be better off from an increase in house prices, and may as a result increase investment orientation; those owning less housing than they plan to consume in the future will be made worse off, and may decrease investments as a result. On average, since there is high owner-occupation in Greece (2nd highest percentage in the European Union with 84.6%, only 0.2 below Spain), there should be long term credit effect.

Second it may be that the higher volatility of stock markets causes short-run responses to increase in stock wealth. If investment decisions are costly to reverse (e.g., if there are costs of liquidating

consumer durables, "habit formation" effects, etc.) then consumers will respond less to volatile changes in wealth. Indeed, several studies have found that consumers' short-run responses to stock wealth are evident as they wish to take advantage of the capital appreciation and redirect their money in other forms of investment including the real estate market.

Sinai and Souleles (2005) report that housing wealth may be superior to stock wealth, since maximum permissible loan-to-value ratios on mortgages are much higher than margin limits on stocks, and because mortgage interest is tax-deductible, while margin loan interest is not. Calomiris et al. (2012) find that stock wealth effects, elasticities, and wealth effect derivatives are small relative to comparable effects relating to housing wealth. They consider two possible explanations for this finding: the relatively high volatility of stock wealth, and the relatively low proportion of the population that owns stock. Our findings thus reconcile the existing evidence by showing that investments in the real estate market is a less risky option and it needs time in order real estate prosperity to divert in the stock markets. It is evident that in the short term there is a wealth effect (i.e. diversion of funds from the stock market to the real estate) but not a credit effect (transfer of wealth from the real estate market to stock exchanges).

7.2 How generalizable are the results from this relatively small country to settings in larger countries?

The Greek market has been underestimated for decades due to its relative small size and peripheral location. The recent sovereign debt crisis with its severe impacts in real estate market and the stock market indicates that Greece has a dynamic market and that events taking place there have a significant impact on the European and Global markets. It has been mainly because of Greece that European Union decided to proceed to extensive reforms. Such a restructuring has never taken place before in any member of the Union but because of this knowledge Italy, Spain, Portugal and Ireland experienced at an earlier stage debt reorganisation. The case of Greece has been extreme, is still progressing and for this reason it is discussed continuously in the international media. Many international finance books are dedicating section (s) to educate students on governmental debt issues while a new research field named 'Financial Literacy' was developed since after to deliver citizens the basic finance knowledge.

Our study documents that in the short-run there is a one-way causal effect running from stock market towards house market. This indicates that investors use their investment appreciation during the bull periods and they invest in the real estate market or redirect their capital during the bear market to other sources of investment including property. Similar can be the case in any other countries where the

people experience reducing income or losses from investments. Great impact of our results may apply in the case of the UK following the Brexit outcome. Evidently the real estate market has received pressure despite the great demand for housing with Fitch declaring that UK will be among weakest housing markets in the world in 2018.

8. Summary and Conclusions

This study investigates the dynamic linkages between the prices of house market and the prices of stock market. Initially, the empirical analysis, employ the conventional ML Johansen's and the ARDL cointegration techniques and document linear evidence supporting the existence of a long-run causal linkage between the prices of the two markets. Particularly, Johansen's method detected evidence supporting a "credit effect" whilst through the ARDL approach there is evidence of both the "wealth effect" and the "credit effect" in the long-run; in the short-run, only one-way weak causal effect running from stock market towards house market is reported. This finding differentiates our study from earlier evidence by Kapopoulos and Siokis (2005); Gounopoulos et al. (2012) which are only in favour of a "wealth effect".

It follows the examination of the non-linear cointegration methodology, based on the specification of TAR and MTAR models, to further investigate the possibility of asymmetric adjustment to the long run equilibrium. The results from both specifications confirm the existence of a long run causal relationship (wealth-type effect) between the two markets while the results from the MTAR model further reveal that the adjustment to equilibrium process is asymmetric and is considerably stronger for positive deviations from the equilibrium.

This study builds in a natural experiment, the deep debt financial crisis of Greece. Thus, for first time it documents that wealth effect holds during the crisis period as it has been the credit shortage and fall of the stock market that affected the real estate market. We do not document opposite direction and any impact of the property market on the prices of the companies in the stock exchange. Evidently real estate prices are adapted gradually to new levels and can have an impact to the stock market only in the long term.

The findings can be of major importance for policy makers as well as for practitioners as they reveal the causal direction of the detected correlation between the studied markets. Our results can be very helpful to the economic policy authorities, in decision making and effective validation of the undertaken

economic policy. Furthermore, it could be proved useful for investors since it constitutes a useful tool in predicting the future movements of the price indices in question.

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Appendix A: Definitions of Variables

House Prices: We use the Real Estate Price Index in order to account for the Residential Properties Prices in Greece. The data on the Index have been extracted from the Bank of Greece the most reliable source of

information. The Bank of Greece compiles Real Estate Price Indices by using primary data/estimates about values and quality features of both residential and commercial properties.

Stock Price: We employ the Athens Stock Exchange General Index (ASEGI) to interpret the movements in the stock market. ASEGI is a capitalization-weighted index of Greek stocks listed on the Athens Stock Exchange. The index was developed in December 31, 1980.

Wealth Effect: Is the premise that when the value of stock portfolios rises due to escalating stock prices, investors feel more comfortable and secure about their wealth, causing them to spend more. According to Portfolio Theory by Markowitz (1952) investors always look for investment channels in order to differentiate their investment risk. Thus they direct a proportion of their gained capital from the stock markets to the real estate in order not only to spread out the risk but also to achieve further benefits. The wealth effect refers to the psychological effect of asset value increases, such as those experienced during a bull market, on spending patterns.

The concept focuses on how the feelings of security, referred to as consumer confidence, bolstered by the rising value of assets, such as investment portfolios and real estate, lead to higher levels of spending, correlating with lower levels of savings

Credit Effect: It indicates the impact that real estate prices have on the prices of the companies in the stock exchange. This can happen through the collateral market route. Specifically it is well known that companies borrow in their effort to achieve higher level of liquidity. In the case of a credit effect an increase in the prices of real estate would have a positive impact in the business world as this will drive to lower cost of debt and will create flexibility into new investments. Those investment will cause increase in the value of the company and will be translated to an increase in the stock price.

Persistent Effect: It explores the origins of the effect by focusing on investment in capital, a key component of output, which typically accounts for a large part of the variations in output during crises. Persistent effect investigate whether investment declines after a financial crisis and, if it does, for how long and by how much.

Difference in House Prices: % house price change over a quarter earlier.

Difference in Stock Prices: % stock price change over a quarter earlier

Appendix B: Commercial Real Estate and Stock Returns

Real estate prices and stock prices are both affected by the general level of economic activity.

Since the crisis hit and in 2009, the average house price dropped. Residential property prices have been falling in Athens since 2008:

- In 2008, house prices in Athens fell by 0.77% (-3.59% in real terms)

- In 2009, house prices fell by 4.21% (-5.99% in real terms)
- In 2010, house prices fell by 5.83% (-10.45% in real terms)
- In 2011, house prices fell by 7.97% (-10.43% in real terms)
- In 2012, house prices plunged by 12.94% (-13.92% in real terms)
- In 2013, house prices plunged by 11.45% (-9.48% in real terms)
- In 2014, house prices fell by 6.65% (-4.90% in real terms).
- In 2015, house prices fell by 5.47% (-4.91% in real terms)

Although we expect some economic shocks to cause stock prices and real estate prices to move together, other shocks are likely to cause stock prices and real estate prices to move in opposite directions.

• Increased economic activity, caused for example by political changes, can boost both stock prices and real estate prices.

• Improved investment opportunities in the corporate sector may boost stock prices but exert upward pressures on real interest rates, thereby reducing commercial property values, even if rental prices increase.

• Foreign competition may depress wages in both the corporate and construction sectors, which can lead to increased corporate profits (and therefore higher stock prices) but decreased property values because of the drop in replacement values.

One can plausibly argue that the factors that induce a negative relation between real estate values and stock prices are more relevant for the large, developed economies in Europe, North America, and Japan than in smaller markets. For example, some observers have argued that one of the contributors to the recent bull markets in the United States was reductions in real wage rates caused by technological changes and foreign competition.

Appendix C: Real Estate General Index in Greece

The table presents the Real Estate General index in quarterly basis. Columns 5-8 present the percentage difference between the quarters. For the period 1997-2005 the House Price Index for all urban areas of the country was compiled by the Real Estate Analysis Section as the weighted average of the next two indices (for Athens and other urban areas or provincial towns). The stock (in m2) of houses in such areas is used as weight. Since 2006 the index for all urban areas has been compiled on the basis of detailed data collected from all credit institutions of the country.

Year	Quarter				(%) Change				Annual Average	(%) Change
	I	II	III	IV	I	II	III	IV		
1997	96.2	98.2	100.2	105.4		2.0	2.0	5.1	100.0	9.7
1998	110.1	113.9	115.0	118.4	4.4	3.4	0.9	2.9	114.4	14.4
1999	120.4	123.6	125.3	128.8	1.6	2.6	1.3	2.8	124.5	8.9
2000	132.1	135.7	138.8	144.2	2.5	2.7	2.3	3.9	137.7	10.6
2001	150.5	156.1	159.5	164.0	4.3	3.7	2.1	2.8	157.5	14.4
2002	171.5	180.3	180.7	184.9	4.5	5.1	0.2	2.3	179.3	13.9
2003	188.6	187.5	189.0	190.9	3.0	-1.8	0.0	0.4	189.0	5.4
2004	190.6	191.6	193.3	198.0	-0.8	-0.1	0.8	3.9	193.4	2.3
2005	205.2	211.6	216.9	224.1	1.9	2.3	1.1	3.2	214.5	10.9
2006	233.3	238.8	243.6	253.4	4.6	2.6	0.4	3.6	242.3	13.0
2007	254.1	256.0	258.8	260.2	1.4	-0.1	1.7	0.7	257.3	6.2
2008	260.8	261.0	261.4	261.0	-0.1	0.1	-1.0	0.2	261.1	1.5
2009	250.3	250.7	248.3	250.1	-3.6	-0.3	-1.8	1.5	249.8	-4.3
2010	247.2	241.9	234.1	232.5	-0.3	-1.3	-3.8	-0.3	238.9	-4.4
2011	232.4	229.0	224.5	217.0	-0.7	-1.9	-1.4	-4.0	225.7	-5.5
2012	207.8	203.2	196.5	189.3	-3.1	-3.2	-3.0	-4.1	199.2	-11.8
2013	184.7	179.1	175.7	170.2	-3.1	-3.5	-1.1	-4.0	177.4	-10.9
2014	166.6	163.7	162.3	160.5	-2.8	-2.9	-0.1	-0.7	163.3	-8.0
2015	159.8	155.4	152.6	151.8	-0.8	-3.3	-1.9	-1.0	154.9	-5.1
2016	152.7	151.6	150.3	…	-0.3	-0.6	-0.8			

Appendix D: Stock Market General Index in Greece

The Athens Stock Exchange General Index is a capitalization-weighted index of Greek stocks listed on the Athens Stock Exchange. The index was developed with a base value of 100 as of December 31, 1980. We present quarterly stock market index in additional to the percentage difference between the quarters.

Year	Quarter	(%) Change	Annual Average	(%) Change

	I	II	III	IV	I	II	III	IV		
1993	768.6	761.0	823.4	958.6	14.0	-2.26	8.2	16.3	958	42.5
1994	1,003	849.3	851.5	868.9	4.6	-15.3	1.8	2.2	868	-9.3
1995	824.6	895.0	949.9	914.1	-5.0	8.5	5.9	-3.7	914	5.9
1996	994.8	910.1	953.6	933.4	8.8	-8.5	4.7	-2.1	933	2.0
1997	1,368	1,507	1,641	1,479	46.6	10.1	15.5	-14.6	1479	58.5
1998	2,005	2,365	2,120	2,737	35.6	17.9	-16.1	29.0	2737	85.0
1999	3,376	4,031	5,667	5,535	23.3	19.4	40.5	-2.3	5535	102.2
2000	4,793	4,054	4,178	3,388	-10.5	-15.4	5.0	-18.2	3388	-38.7
2001	3,044	2,741	2,226	2,591	-10.2	-10.3	-18.7	17.8	2591	-23.5
2002	2,280	2,237	1,837	1,748	-12	-1.8	-17.2	-7.1	1748	-32.5
2003	1,467	1,892	2,019	2,263	-16.0	29.0	6.7	13.0	2263	29.4
2004	2,365	2,349	2,328	2,786	7.7	0.7	-0.9	19.6	2786	23.1
2005	2,854	3,065	3,381	3,663	4.3	3.9	10.3	9.9	3663	31.4
2006	4,122	3,693	3,931	4,394	13.3	-10.9	9.7	10.7	4394	19.9
2007	4,643	4,843	5,123	5,152	6.0	2.65	7.7	4.6	5152	17.2
2008	3,985	3,439	2,865	1,786	-22.4	-10.0	-16.5	-40.8	1786	-65.3
2009	1,684	2,209	2,661	2,196	-2.7	39.4	6.0	-13.2	2196	22.9
2010	2,067	1,434	1,471	1,413	-5.8	-30.0	1.6	-3.9	1413	-35.6
2011	1,535	1,279	798	680	8.6	-16.6	-37.6	-14.7	680	-51.8
2012	728.9	611.1	744.4	907.9	7.1	-16.1	21.8	22.0	907	33.3
2013	869.1	851.4	1,021	1,162	-4.2	-2.0	20.0	13.7	1162	28.1
2014	1,342	1,228	1,058	826.1	15.4	-8.4	-13.8	-21.9	826	-28.9
2015	765.3	797.5	642.7	631.5	-7.3	3.9	-19.2	-1.7	631	-23.6
2016	571.5	544.7	565.5	643.6	-9.5	-13.7	3.8	13.8	643	1.9

Table 1: Financial Data of Greece

GDB is a monetary measure of the market value of all final goods and services produced in a period (quarterly or yearly) of time Governmental debt is the debt owed by a government. It refers to the difference between government receipts and spending in a single year. Interest rates of 10 years Bonds: The yield on a Treasury bill represents the return an investor will receive by holding the bond to maturity. Homeownership: is the percentage of homes that are owned by their occupants. The homeownership rate is computed by dividing the number

of owner-occupied housing units by the total number of occupied housing units. Credit rating is an evaluation of the credit risk of a prospective debtor (an individual, a business, company or a government), predicting their ability to pay back the debt, and an implicit forecast of the likelihood of the debtor defaulting.

	GDP (USD Dollar)	Greece Public Debt	Public Debt (%GDP)	Interest Rates of 10 Year Greece Bonds (%)	Homeowne rship (%)	Credit Rating
1993	108.89	109.32	100.29	25.1		Baa2 (S&P)
1994	116.60	114.55	98.39	22.5		A- (S&P)
1995	136.87	135.58	99.00	18.5		A3 (Moodys)
1996	139.60	147.82	101.30	15.2		BBB+ (S&P)
1997	143.15	142.55	99.5	13.1		BBB (Fitch)
1998	144.42	140.92	97.4	11.4		Baa1 (Moodys)
1999	142.54	145.49	98.9	6.0		A2 (Moody's)
2000	130.13	136.89	104.9	5.5		A (S&P)
2001	136.19	145.95	107.1	5.1		A (S&P)
2002	153.83	162.08	104.9	4.5		A1 (Moodys)
2003	201.92	205.32	101.5	4.4		A+ (S&P)
2004	240.52	247.87	102.9	4.6	85.2	A+ (S&P)
2005	247.78	266.20	107.4	4.4	84.6	A (Fitch)
2006	273.31	283.80	103.6	4.7	81.6	A1 (Moodys')
2007	318.49	328.80	103.1	5.0	80.8	A (Fitch)
2008	354.46	389.43	109.4	5.1	79.5	A (S&P)
2009	330.87	419.92	126.7	5.0	78.7	A- (S&P)
2010	299.36	438.93	146.2	5.7	77.2	BBB+ (S&P)
2011	287.8	495.95	172.1	12.7	76.3	BB- (S&P)
2012	245.67	391.98	159.6	18.1	75.9	SD (S&P)
2013	239.86	425.66	177.4	8.2	75.9	Caa3 (Moody's)
2014	236.08	424.75	179.9	5.4	75.8	B (S&P)
2015	194.86	345.90	176.8	10.7	74.2	B (S&P)
2016	194.56	348.71	180.8	6.9	73.9	B- (S&P)

Table 2: Unit Root tests

ADF: Augmented Dickey-Fuller test. ADF-GLS: Elliott-Rothenberg-Stock DF-GLS tests. The optimal lag structure of the ADF test is chosen based on the Akaike Information Criterion and are reported in the parentheses. The respective 1% then 5% and 10% critical values for the ADF test are -3.58, -2.93, -2.60 and -4.15, -3.50, -3.18 for each model for models C and C/T, respectively. The respective 1% then 5% and 10% critical values for the DF-GLS test are -2.598, -1.945, -1.613 and -3.690, -3.122, -2.827 for models C and C/T, respectively. ***, ** and * denote significance at the 1, 5 and 10%, levels, respectively.

Variable	ADF		ADF-GLS	
	C	**C/T**	**C**	**C/T**
lnHP	-1.392	0.414	-1.279	-1.265
lnSP	-1.136	-2.277	-1-245	-1.535
ΔlnHP	-1.507	-5.209***	-1.037	-3.474**
ΔlnSP	-5.701***	-5.822***	-2.166**	-5.320***
		Hot Period		
	C	**C/T**	**C**	**C/T**
lnHP	-2.062*	-1.524	-0.205	-1.943**
lnSP	-2.742**	-2.689	-1.607	-2.236**
ΔlnHP	-3.770***	-4.279***	-3.783***	-4.271***
ΔlnSP	-5.018***	-4.980***	1.515	2.156**
		Cold Period		
	C	**C/T**	**C**	**C/T**
lnHP	1.264	-2.213**	-0.016	-1.489
lnSP	-2.186**	-2.896***	-1.106	-2.641**
ΔlnHP	-3.755 ***	-3.990***	-3.434***	-4.051***
ΔlnSP	-3.732***	-3.838***	-3.617***	-3.988***

Table 3: Johansen's Cointegration tests

The model tests for cointegration between the log of stock market price index and that of the house market in the bivariate context.

	Trace Statistic	Max-Eigen statistic

LSP/LHP	Rank = 0	14.95*	11.08*
	Rank <= 1	3.88**	3.87**
	Hot Market		
LSP/LHP	Rank = 0	8.9	5.45
	Rank <= 1	3.45*	3.45*
	Cold Market		
LSP/LHP	Rank = 0	15.40**	15.32**
	Rank <= 1	0.08	0.08

Table 4: Error Correction Model Estimates

Panel A: Normal Tests

Error Correction	D(LSP)	D(LHP)
Constant	-0.02	0.001
	(-1.36)	(0.73)
CointEq1	-0.11	-0.02
	(-2.72)***	(-2.14)**
D(LSP(-1))	0.47	
	(4.27)***	
D(LHP(-1))		0.74
		(9.26)***
LHP(-4))	2.62	
	(2.74)***	
Adj R^2	0.25	0.66
N	72	72
	Hot Period	
Error Correction	D(LSP)	D(LHP)
Constant	-0.0007	0.076
	(0.35)	(0.055) *
CointEq1	-0.15	-0.01
	(-2.56)***	(-2.004)**
D(LSP(-1))	0.32	
	(2.25)**	
D(LSP(-3))	0.34	
	(2.33)**	
D(LHP(-1))		0.39
		(2.73)***
Adj R^2	0.26	0.28
N	42	42
	Cold Period	
Error Correction	D(LSP)	D(LHP)
Constant	-0.03	-0.02
	(0.88)	(-4.17)***
CointEq1	-0.22	-0.006
	(-2.38)**	(-2.70)***
D(LSP(-1))	0.48	
	(2.91)***	
D(LSP(-3))		-0.04
		(-2.43)**
D(LHP(-2))		0.30
		(1.71)*
Adj R^2	0.32	0.30
N	30	30

Panel B: Bootstrapping Tests

Error Correction	D(LSP)	D(LHP)
Constant	0.625	0.002
	(0.156)	(0.258)
CointEq1	-0.132	-0.02
	(-2.12)**	(-2.14)**
D(LSP(-1))	0.347	
	(2.91)***	
D(LHP(-1))		0.78
		(12.81)***
LHP(-4))	-0.219	
	(1.741)*	
Adj R^2	0.176	0.632
N	500	500
	Hot Period	
Error Correction	D(LSP)	D(LHP)
Constant	0.0237	0.076
	(5.46)***	(1.91)*
CointEq1	-0.15	-0.08
	(-2.56)***	(-1.854)*
D(LSP(-1))	-0.014	
	(-0.872)	
D(LSP(-3))	-0.0031	
	(-0.16)	
D(LHP(-1))		-0.010
		(-1.30)
Adj R^2	0.26	0.04
N	150	150
	Cold Period	
Error Correction	D(LSP)	D(LHP)
Constant	-0.0353	-0.017
	(0.248)	(-3.47)***
CointEq1	-0.22	-0.016
	(-1.83)*	(-2.12)**
D(LSP(-1))	0.417	-0.0461
	(2.31) **	(3.54)***
D(LSP(-3))		-0.0317
		(-1.83)*
D(LHP(-2))		0.228
		(1.06)
Adj R^2	0.138	0.416
N	150	150

Table 5: Short-run Granger Causality tests

D(LSP)			D(LHP)		
Excluded	Chi-sq	Prob.	Excluded	Chi-sq	Prob.
			Whole Period		
D(LHP)	3.22	0.08	D(LSP)	0.05	0.82
			Hot Period		
D(LHP)	0.29	0.59	D(LSP)	0.09	0.76
			Cold Period		
D(LHP)	3.33	0.08	D(LSP)	6.71	0.01

Table 6: Bounds test for the existence of cointegration

The critical value bounds are computed by stochastic simulations using 20000 replications.

Dependent Variable	**F-statistic**	**90% Lower Bound**	**90% Upper Bound**	**95% Lower Bound**	**95% Upper Bound**
ΔlnHP	9.22	3.02	3.51	3.62	4.16
ΔlnSP	4.15				

Table 7: Error Correction Estimates and Long-run Coefficients

Panel A: **Wealth effect hypothesis**			
Specifications	LHP		D(LHP)
D(LHP(-1))	0.257	Constant	3.503
	(2.314)**		(8.063)***
D(LSP)	0.006	LSP	0.339
	(0.619)		(3.442)***
D(D_2001Q4)	0.015	D_2001Q4	0.375
	(1.243)		(2.968)***
D(D_2008Q2)	-0.008	D_2008Q2	-0.189
	(-0.666)		(-0.916)
D(D_2012Q4)	-0.013	D_2012Q4	-0.263
	(-1.009)		(-3.613)***
CointEq(-1)	-0.048		
	(-5.722)***		

Panel B: **Credit effect hypothesis**			
Specifications	LSP		LHP
D(LSP(-1))	0.321	Constant	-2.303
	(3.277)***		(-0.815)
D(LHP)	0.299	LHP	1.585
	(0.484)		(2.685)***
D(D_2001Q1)	-0.162	D_2001Q1	-1.012
	(-1.252)		(-2.555)**
D(D_2008Q4)	-0.461	D_2008Q4	-1.078
	(-3.615)***		(-3.429)***
D(D_2012Q2)	-0.253	D_2012Q2	0.207
	(-1.994)*		(0.570)
CointEq(-1)	-0.189		
	(-3.734)***		

Table 8: TAR/MTAR Estimates

The reported results represent empirical sizes of the test of the symmetry hypothesis at the 5% level of significance for the TAR/MTAR model under deterministic and consistent threshold estimation using alternative covariance matrix estimators.

	TAR Estimates		**MTAR Estimates**	
Variables	**Coefficient**	**t-value**	**Coefficients**	**t-value**
Above Threshold	-0.668	**3.081*** **	-0.926	**3.564*** **
Below Threshold	-0.310	**2.425** **	-0.255	**2.096** **
Differenced Residuals(t-1)	0.094	**0.846**	0.087	**0.752**
Differenced Residuals(t-2)	0.029	**0.481**	0.148	**1.069**
Threshold value (tau):	0.088		0.045	
F-equal:	3.224		11.778	
F-joint (Phi):	10.624		15.999	

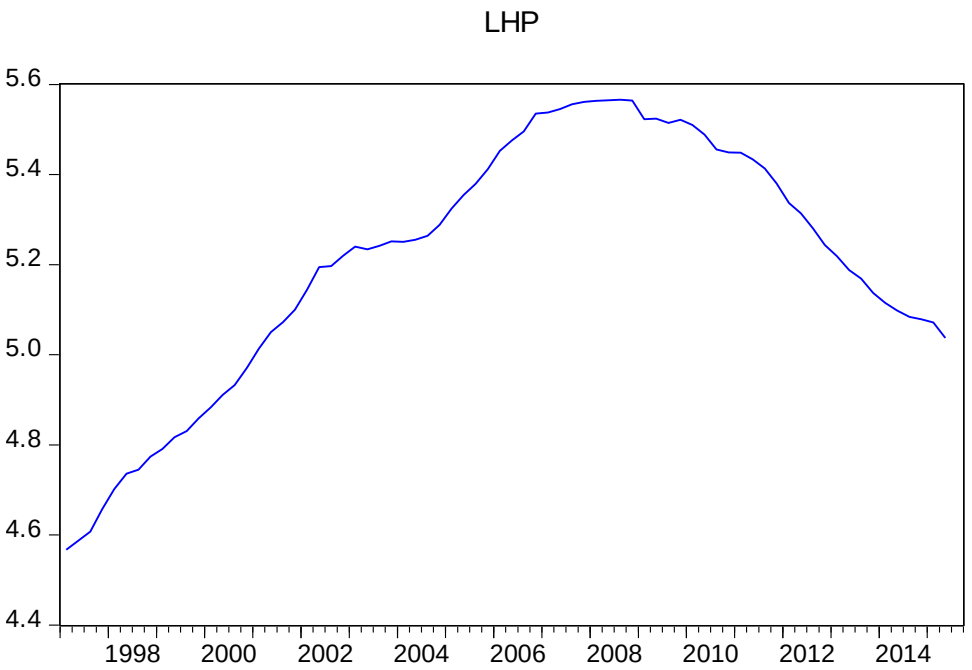

Figure 1: Greece's House Price Index (1997 Q1 – 2015 Q2)

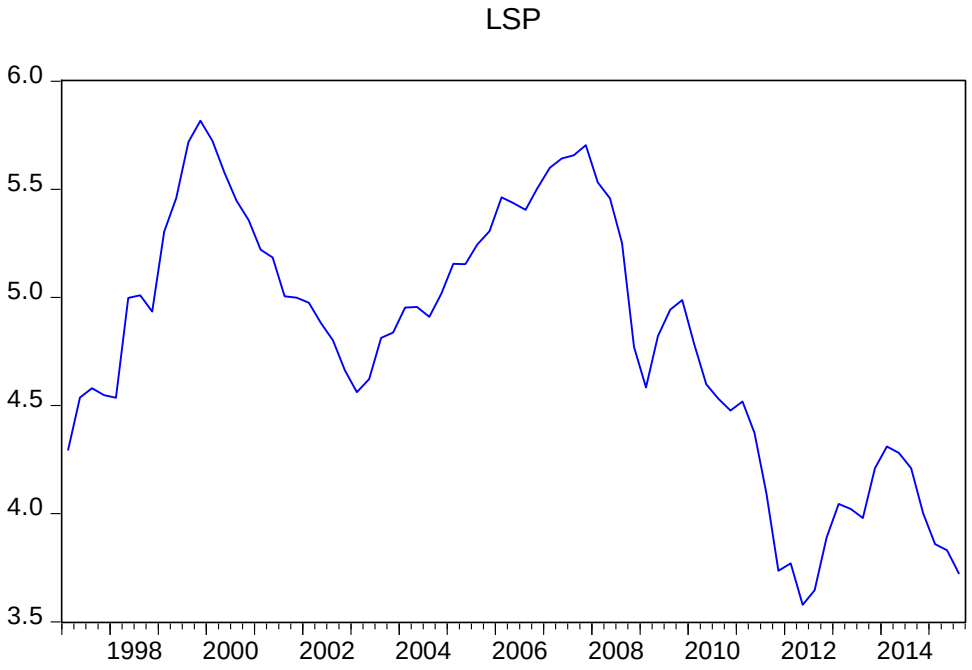

Figure 2: Athens Stock Market Index (1997 Q1 – 2015 Q2)

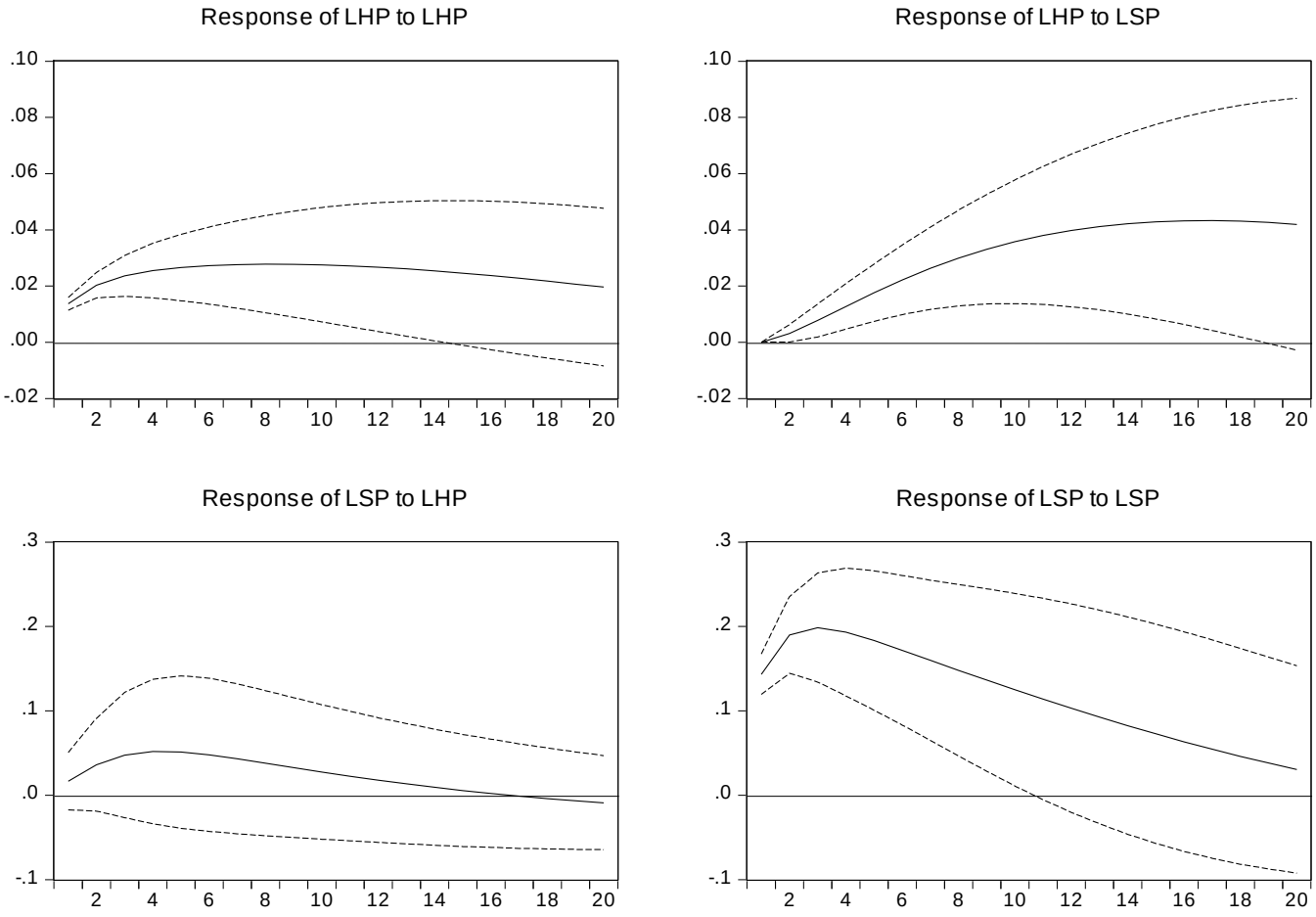

Figure 3: Impulse Response Function of a 1% Shock on Stock Price and Real Estate Price, with 95% confidence bands for the time period of 1997 Q1 – 2015 Q2

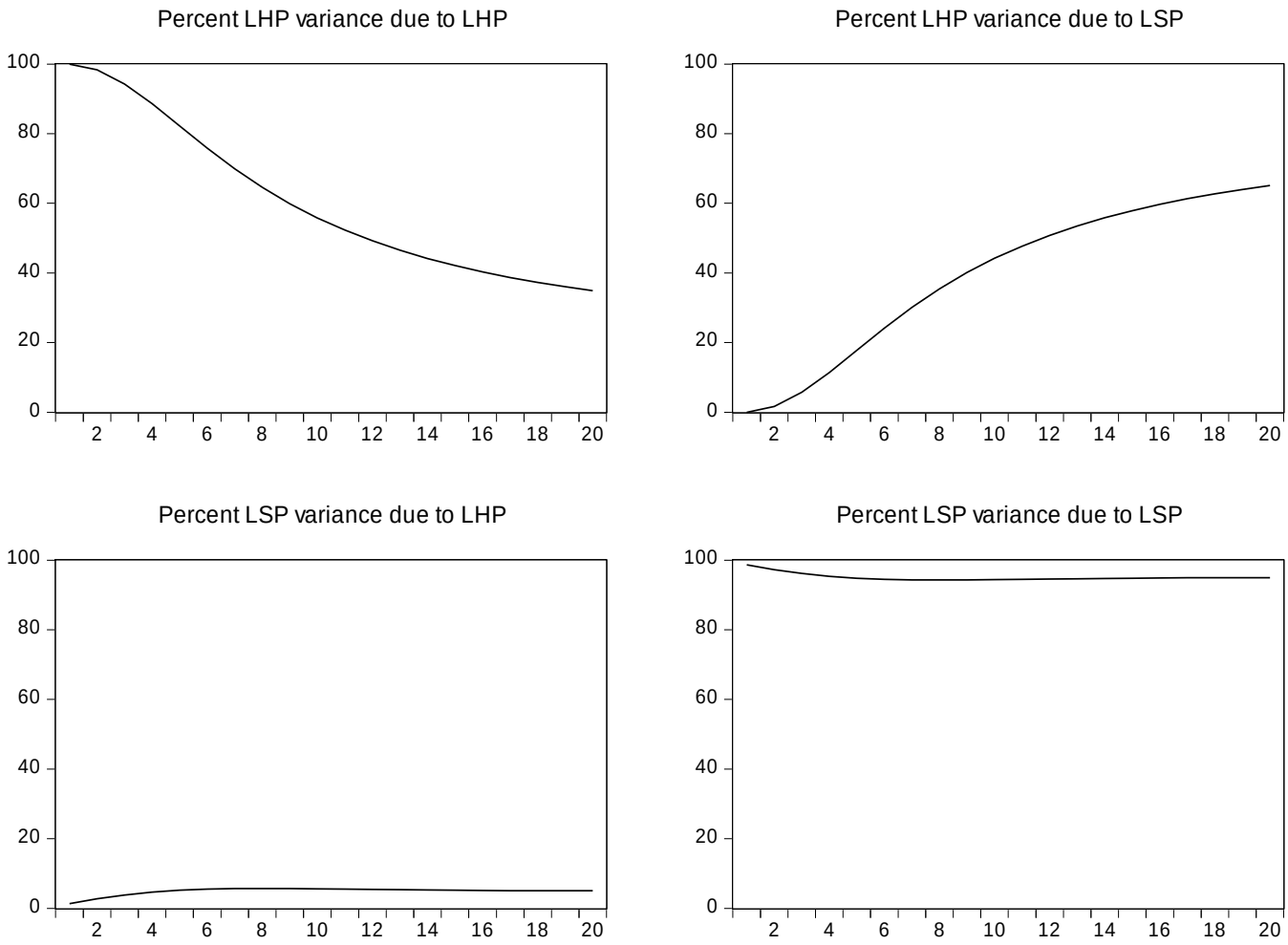

Figure 4: Variance Decomposition for Stock Price and Real Estate Price series