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The Long-Run Relationship between Saving and Investment in Greece

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Abstract

This paper studies the relationship between saving and investment rates in Greece using annual time series data for the period 1980-2012. The stationarity analysis is conducted by applying Zivot and Andrews unit root test while for cointegration we apply the ARDL bounds testing approach developed by Pesaran-Shin-Smith. Cointegration test show the presence of a long run relationship between the series that we examine in the presence of a structural variance. Therefore, the Feldstein–Horioka puzzle which is presented in the Greek open economy with a high rate of capital mobility during the 1980's and 1990's is not valid. The augmented Granger causality test shows that both in the short and long run there is a one direction causal relationship between savings and investment with direction from savings to investment. Finally, variance decompositions show that domestic savings are the main cause of investment in a long run basis.

Keywords: Feldstein-Horioka puzzle, structural break, ARDL model, error correction model

1. Introduction

The role of saving and investment on promoting the economic growth for many countries has drawn the attention of many analysts for many years. Theoretical growth models such as Lewis (1955) established the link between saving and investment through its effect on capital accumulation. According to the growth model of Harrod-Domar, which was developed independently by Roy Harrod in 1939 and Evsey Domar in 1946 and it was the precursor to the exogenous growth model, the growth rate of output is related directly to the savings or investment.

However, the Solow-Swan growth model, which was developed by Robert Solow and Trevor Swan in 1956 and it is known as exogenous growth model, attempts to interpret the long-run economic growth by looking at productivity, capital accumulation and technological progress. The model of Solow-Swan proves that saving has no impact on long run growth.

In contrast, the endogenous growth theory developed by Romer (1986) Lucas (1988) and Barro (1990) suggests that the accumulation of physical capital drives economic growth in the long-run. So, all growth model theories show that saving and investment play an important role in promoting economic growth. Economic development in an open economy depends on the availability of domestic savings and access to international capital markets. But, in an open economy the strong link between saving and investment may disappear because savings can be transferred anywhere and their return will be so high that they can be placed in investment activities. Hence, the relationship savings investment depends on the degree of openness of an economy to international capital movements

On the other hand, high degree of capital movement within the country increases the availability of domestic savings for economic growth, thus, improving the capital efficiency. High degree of capital mobility within a country also affects the fiscal and current account policies of an economy to identify the burden of taxes on investment. Also, public deficit on domestic investment depends on the foreign capital movement. However, foreign direct investment (FDI) is not desirable in most of developing countries, as the cost of capital outflow sometimes exceeds the benefits of inflows

The paper of Feldstein and Horioka (1980) analyzed the relationship between saving and investment for 21 industrialized countries of OECD and found a strong relationship for these two variables and perfect capital mobility. This result was unexpected in an open economy thus there was some doubt from many researchers. At this point, it is also worth noting that the theoretical works identify an investment mechanism through which savings affect economic growth and strongly relate domestic savings to investment. However, it is unclear which one is the driving force for countries' growth (Schmidt, 2003). There seems to be a conventional view that savings derive capital accumulation. If this is correct, policies should aim to a higher savings rate. However, the effectiveness of such policies depends not only on the achievement of a large savings percentage, but also on the responsiveness of investment to saving promoting policies. If only a small portion of investment results from domestic savings, meaning that investment is not a savings-driven process, such development policies are likely to be unsuccessful. This highlights the importance of the analyses not only on the correlation between domestic saving and investment but also on the direction of causal relationship, if any, between them on the examined time period.

Taking into account the previous arguments, this paper examines if there exists a relationship between savings and investment in Greece. During the last years, Greece started important structural reforms under the surveillance of International Monetary Fund and European Union starting a memorandum which was established by its creditors. The results of this policy model were catastrophic. Many bank deposits both from citizens and enterprises moved to other countries, tax scale increased and as a consequence many companies were transferred to neighbor countries and unemployment reached the highest rates of all European countries (30% approximately). This resulted in the decrease of growth by 25% during the last years and more than 23% of households live below the poverty line. Although this bad policy was recognized both from IMF and EU, lenders insist on this austerity policy. These developments modified the relationship between domestic savings and investment as well as international capital mobility.

Data availability for Greece for a large time period (1980-2012) allows us to investigate the relationship between savings and investment. The empirical analysis presented on this paper is based on cointegration test on ARDL for the long run relationship between examined series with the presence of structural variance as well as error correction model for the short and long run causal relationship of the variables.

Many studies have examined the relationship between savings and investment. A widely known study is that of Martin Feldstein and Charles Horioka which was published in 1980 and showed that there is a high positive correlation between domestic savings and investment in perfect mobility conditions. The result of their research doesn't agree with the theory of capital's perfect mobility where there is no relation between domestic savings and investment.

The last three decades many studies have tried to explain the "Feldstein-Horioka puzzle" either theoretically or empirically for different countries based on time series databases. Some of these empirical studies found high values on b coefficient and agreed with the Feldstein-Horioka paper while other papers found the value of coefficient b to be null, thus rejecting the Feldstein-Horioka paper. Among them there is a third group of researchers who accept a high positive correlation between domestic savings and investment in situations of low capital mobility. According to these researchers, in countries where there is perfect capital mobility, savings and investment, there is high correlation regarding the growth rate, the openness and the size of the examined country.

The first group consists the papers of Golub (1990), Feldstein and Bachetta (1991) Sinn (1992), Obstfeld and Rogoff (2000) and Petreska, D., and Blazevski N.M (2013). Specifically: Golub (1990) estimates b coefficient in a sample of 16 OECD countries for two sub-periods, 1970-1979 and 1980-1986 and the result agrees with that of Feldstein and Horioka. Feldstein and Bachetta (1991) estimate a sample of 23 OECD countries for the period 1960- 1986 and find a high positive correlation between domestic savings and investment**.** Sinn (1992) made an empirical test for 23 OECD countries for the period 1960-1988, finding β coefficient values that vary from year to year between 0.4 and 0.9. These values are still high enough to re-confirm the existence of the puzzle. Obstfeld and Rogoff (2000) estimated a β coefficient of 0.6 for 24 OECD countries for the period 1990-1997, which is significantly lower than that of Feldstein and Horioka. Coakley et al. (2001), through a panel regression for 12 OECD countries for the period 1980-2000, obtained a relatively high value for β of 0.68. Petreska, D. and Blazevski N.M (2013) investigate the relationship of savings and investment in three groups of countries, the South-East Europe (SEE), Central and Eastern Europe (CEE) and the Commonwealth of Independent States. Using annual data from 1991-2010 and cointegration technique found that β coefficient is high in all three group of countries that they examine.

The second group consists of the papers of Yamori (1995), Cooray and Sinha (2005), Ghosh and Dutt (2011), Sinn (1992); Coakley et al. (2004). Specifically: Yamori (1995) estimated savings and investment correlations for Japan for the period 1970-1985 using ordinary least squares (OLS) and two-stage least squares (2SLS). The results revealed that there is no correlation between savings and investment suggesting perfect capital mobility.

Cooray and Sinha (2005) examined the relationship between domestic savings and investment in 20 poor countries in Africa. Their result showed that the relationship between domestic savings and investment is very low, which means that most investment is financed by foreign rather than domestic savings. Ghosh and Dutt (2011) used a time series approach on a sample of five countries (USA, UK, France, Japan, and Germany) for the period 1960-2008. With the exception of France, where β is estimated at a high level of 0.82, for the other four countries low β coefficients were estimated, which refutes the hypothesis of low international capital flows. According to authors, in these four countries domestic investment is financed by foreign savings (as is the case of USA), or excess domestic savings are invested abroad (as in the case of Japan).

The third group consists of the papers of Murphy (1984), Sinha and Sinha (2004), Bahmani-Oskooee and Chakrabarti (2005), Ketenci (2010). Specifically: Murphy (1984) divided his sample of 17 OECD countries into ten small and seven large countries. The result showed that the group of large countries had a β coefficient of 0.98, while the estimated coefficient for small countries was 0.59. He argued that these results are consistent with the expected country size effect in terms of high capital mobility between countries. Sinha and Sinha (2004) studied the short-run and long-run relationships between saving and investment rates for 123 countries using an error correction framework. Their results show that there is more capital mobility in countries with high per capita income.

Bahmani-Oskooee and Chakrabarti (2005), examined the relationship of savings and investment in a sample of 126 countries for the period 1960-2000. Their findings show that there is a positive (0.54 to 0.69) relationship between savings and investment, and that the size of the country matters. Countries with high income have a higher β coefficient than those with low incomes.

Ketenci (2010) investigates investment-savings relationships in 26 OECD countries using annual data for the period 1970-2008. It divides the countries into three different groups EU15, NAFTA and G7. The empirical results of this research show that for G7 countries b coefficient is higher than b coefficient of EU15 and NAFTA. The empirical findings reveal that the Feldstein-Horioka puzzle exists only in the panel of G7 countries where the saving-retention coefficient is estimated at the level 0.754 and 0.864 for the full sample of G7 countries and for stable countries, respectively. The estimated saving-retention coefficient for the G7 group of unstable appear at the 0.482 level, indicating a higher level of capital mobility in unstable countries compared to stable ones. This conclusion is supported by estimations for OECD and EU15 countries.

The rest of the paper is organized as follows. Section 2 describes the data and methodology as well as the theoretical model of the Feldstein-Horioka. Section 3 highlights the empirical results and the last section concludes and states the policy implications of the results.

2. Data and Methodology

2.1 Theoretical Model of Feldstein and Horioka

The paper by Feldstein and Horioka (1980) uses data for 21 industrialized OECD countries for the period 1960-1974. They assume that with perfect capital mobility, there should be no relation between domestic saving and domestic investment. Their estimated equation is the following:

$$\left(\frac{I}{Y}\right)_i = \alpha + \beta\left(\frac{S}{Y}\right)_i \tag{1}$$

where $\left(\frac{I}{Y}\right)_i$ and $\left(\frac{S}{Y}\right)_i$ are the ratios of gross domestic investment to gross domestic product and the ratio of gross domestic saving to gross domestic product respectively.

If the value of β is equal to one, this means that the only source of financing domestic investment is domestic saving. In case where β equals zero, this will mean that foreign capital, which substitutes domestic saving, is the only source of financing domestic investment. (Sinha & Sinha, 2004).

One important problem with the Feldstein-Horioka study is that the high positive correlation between the saving rate and the investment rate means low level of capital mobility. On the one hand, the high correlation between saving and investment rates and on the other, perfect capital mobility, has come to be known as the "Feldstein-Horioka puzzle" (Sinha & Sinha, 2004).

A basic point to this "Feldstein-Horioka" puzzle is the β coefficient, which measures the relationship between domestic savings and investment. In their paper in 1980, Feldstein and Horioka estimated a value of the β coefficient close to 1, which in their opinion indicates low capital mobility as opposed to the theory of perfect capital mobility. This means that domestic savings are transformed into domestic investment with foreign capital playing a marginal role (Petreska & Blazevski, 2013).

2.2 Data and Model Specification

The data for this study are from the *International Financial Statistics* of the International Monetary Fund. This publication has annual data for Greece from 1980 to 2012.

In this study we use the reduced-form bivariate model of Feldstein and Horioka (1980) to examine the long-run relationship between domestic saving and investment in Greece and measure the degree of international capital mobility. The model is specified as:

$$\left(\frac{I}{Y}\right)_t = \alpha + \beta\left(\frac{S}{Y}\right) + e_t \tag{2}$$

where $\left(\frac{I}{Y}\right)_t$ and $\left(\frac{S}{Y}\right)_t$ are the ratio of gross domestic investment to gross domestic product and the ratio of gross domestic saving to gross domestic product, and e_t is the disturbance term. In this equation the coefficient β has the most important role and is called the Feldstein-Horioka coefficient, or the link between domestic savings and investment. The value of β ranges between 0 and 1. If β = 1 there is a 100% correlation between domestic investment and domestic savings. This is an absolute financial autarchy, which means that there is no foreign investment in the country, i.e., capital mobility is zero. Another extreme situation is when β = 0, where overall domestic investment is financed with foreign capital, which indicates perfect capital mobility (Petreska & Blazevski, 2013).

2.3 Unit Root Tests with Structural Break

We start from unit root using three methods. The Augmented Dickey-Fuller (1979) test, the Phillips and Perron (1988) test and Elliot, Rothenberg and Stock (1996) test.

The Augmented Dickey-Fuller (ADF) test constructs a parametric correction for higher-order correlation by assuming that the series follows an AR(k) process and adding lagged difference terms of the dependent variable to the right-hand side of the test regression.

Phillips and Perron (1988) propose an alternative (non-parametric) method of controlling for serial correlation when testing for a unit root. The Phillips-Perron (1988) test is suitable for analyzing time series whose differences may follow mixed ARMA (p,q) processes of unknown order in that the test statistic incorporates a nonparametric allowance for serial correlation and heteroscedasticity in testing the regression.

Elliot, Rothenberg and Stock (1996) propose a simple modification of the ADF approach constructing DF-GLS test, in which the time series are detrended so that explanatory variables are "taken out" of the data prior to running the test regression.

However, the results of these traditional tests may be biased due to lack of information about structural break points occurred in series. So, a common problem with the conventional unit root tests (such as the ADF, PP and DF-GLS tests), is that they do not allow for the possibility of one or more structural breaks.

In order to solve the problem we apply the unit root test of Zivot and Andrews (1992) which suggest three models to test for a unit root. These are the following:

$$\Delta X_t = \delta_0 + \delta_1 t + \delta_2 X_{t-1} + \beta_1 DU_t + \sum_{i=1}^{\rho} \gamma_i \Delta X_{t-i} + e_t \tag{3}$$

$$\Delta X_t = \delta_0 + \delta_1 t + \delta_2 X_{t-1} + \beta_2 DT_t + \sum_{i=1}^{\rho} \gamma_i \Delta X_{t-i} + e_t \tag{4}$$

$$\Delta X_t = \delta_0 + \delta_1 t + \delta_2 X_{t-1} + \beta_1 DU_t + \beta_2 DT_t + \sum_{i=1}^{\rho} \gamma_i \Delta X_{t-i} + e_t \tag{5}$$

where DU_t is an indicator dummy variable for a mean shift occurring at each possible break-date (T_B) while DT_t is corresponding trend shift variable.

$$DU_t = \begin{cases} 1, & if \quad t > T_B \\ 0 & otherwise \end{cases} \text{ and } DT_t = \begin{cases} DT_t = t - T_B, & if \quad t > T_B \\ 0 & otherwise \end{cases}$$

The null hypothesis in all the three models is $\delta_2=0$, which implies that the series X_t contains a unit root with a drift that excludes any structural break, while the alternative hypothesis $\delta_2<0$ implies that the series is a trend-stationary process with a one-time break occurring at an unknown point in time. The breakpoint is estimated by the ordinary least squares for t=2,…,T-1, thus (T-2) regressions are run, and the breakpoint is determined by the minimum t statistic on the coefficient of the autoregressive variable ($t_{\delta2}$). The asymptotic critical values for t statistics are tabulated in Zivot and Andrews (1992). In the present paper we choose model (5) as the most suitable for our research according to Sen (2003) reviews.

2.4 ARDL Bounds Testing Approach

After testing the stationarity of the series, we apply ARDL (Autoregressive Distributed Lag) bounds cointegration testing approach developed by Pesaran et al. (2001) to investigate for the long run relationship between saving and investment in the presence of structural breaks for the Greek economy.

The autoregressive distributed lag (ARDL) cointegration technique as a general vector autoregressive (VAR) model of order p in Z_t.

$$Z_t = (IY, SY)'$$

where Z_t is a column vector composed of the two variables

Therefore, before starting the process of ARDL model we find the order of VAR model meaning the number of time lags of the variables in the VAR model. Afterwards, in order to find the optimum length of time lags in the variables we use the minimum value of the criteria Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC) and Hannan-Quinn (HQ) criterion and Likelihood Ratio (LR) criterion.

This method has multiple econometric advantages. For example, the bounds testing ARDL is applicable irrespective of whether variables are I(0) or I(1). Also, the ARDL bounds testing provides with efficient and consistent empirical evidence for small samples data (Pesaran and Shin, 2001).

The ARDL model used in this study is expressed as follows:

$$\Delta IY_t = \alpha_0 + \alpha_1 IY_{t-1} + \alpha_2 SY_{t-1} + \sum_{i=1}^{q} \alpha_{1i} \Delta IY_{t-i} + \sum_{j=0}^{p} \alpha_{2i} \Delta SY_{t-i} + \alpha_3 D_1 + \mu_{1t} \quad (6)$$

$$\Delta SY_t = \beta_0 + \beta_1 SY_{t-1} + \beta_2 IY_{t-1} + \sum_{i=1}^{q} \beta_{1i} \Delta SY_{t-i} + \sum_{j=0}^{p} \beta_{2i} \Delta IY_{t-i} + \beta_2 D_1 + \mu_{2t} \quad (7)$$

where Δ denotes the first difference operator, D is dummy for structural break point and μ_{1t} and μ_{2t} are error term assumed to be independently and identically distributed.

Given that the computation of ARDL bounds testing is known to be sensitive to lag length selection, the optimal lag length of the first differenced regression is chosen based on the minimum value of Akaike, Schwarz and Hannan-Quinn information criteria.

Pesaran et al. (2001) suggests F distribution test for joint significance of the coefficients of the lagged level of variables

The null hypothesis of no cointegration among the variables in equations (5) and (6) is:

$H_0 : \alpha_1 = \alpha_2 = 0$ against the alternative hypothesis of cointegration

$H_1 : \alpha_1 \neq \alpha_2 \neq 0$

and

$H_0 : \beta_1 = \beta_2 = 0$ against the alternative hypothesis of cointegration

$H_1 : \beta_1 \neq \beta_2 \neq 0$

Two sets of critical values for a given significance level can be determined. The first critical value is obtained on the assumption that all variables included in the ARDL specification are I(0), while the second level is obtained on the assumption that the variables are I(1). We reject the null hypothesis of no cointegration when the F-value exceeds the upper critical bounds value. We do not reject the null hypothesis if the F-value is lower than the lower bounds. Finally, the decision about cointegration is inconclusive, if the calculated F-statistic falls between the lower and upper-bound critical value. (see Pesaran et al., 2001).

The next step is to examine the long run relationship between the variables. We use the following equations:

$$IY_t = b_0 + b_1 SY_t + e_t \quad (8)$$

$$SY_t = c_0 + c_1 IY_t + \varepsilon_t \quad (9)$$

where IY_t is gross national investment as a proportion of gross domestic product (GDP), and SY_t is the gross national saving as a proportion of GDP, b_0, c_0 and b_1, c_1 are parameters to be estimated, and e_t, ε_t are error term assumed to be normally distributed. The choice of gross national investment as a share of GDP and gross national saving as a share of GDP is justified following the work of Feldstein and Horioka (1980).

Moreover, a dynamic unrestricted error correction model can be derived from the ARDL bounds testing through a simple linear transformation. The dynamic unrestricted error correction model integrates the short run dynamics with the long run equilibrium. The bounds testing procedure consists of estimating an unrestricted error correction model with the following general form in which each variable is used as a dependent variable). The dynamic unrestricted error correction model is expressed as follows:

$$\Delta IY_t = \gamma_0 + \sum_{i=1}^{q} \gamma_{1i} \Delta IY_{t-i} + \sum_{j=0}^{p} \gamma_{2i} \Delta SY_{t-i} + \lambda_1 ECM_{t-1} + u_t \quad (10)$$

$$\Delta SY_t = \delta_0 + \sum_{i=1}^{q} \delta_{1i} \Delta SY_{t-i} + \sum_{j=0}^{p} \delta_{2i} \Delta IY_{t-i} + \lambda_2 ECM_{t-1} + \mu_t \quad (11)$$

where ECM_{t-1} is the error correction term.

The error correction term (ECM_{t-1}) should be negative and statistical significant. This term indicates the speed of the adjustment and shows how quickly the variables return to the long-run equilibrium.

2.5 Testing Stability in ECM

The existence of cointegration which comes from equations 6 and 7 does not necessarily imply that the estimated coefficients are stable. So, Pesaran et al. (1999, 2001) suggested testing the stability of estimated coefficients using Brown et al (1975) tests known as cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) and Recursive Residuals.

Provided that the plots of these statistics fall inside the critical bounds of 5% significance, one assumes that the coefficients of a given regression are stable.

2.6 The VECM Granger Causality

After the long run relationship among the variables, we examine the direction of causality using the ECM –ARDL model. Granger suggested that in the presence of cointegration once variables are found to be stationary then VECM approach of causal relationship is an appropriate approach to detect the causality in a long and short run level. This method is followed by the two steps of Engle and Granger (1987) and employed to investigate the long-run and short-run dynamic causal relationships. The first step estimates the long-run parameters in Equations 8 and 9 in order to obtain the residuals corresponding to the deviation from equilibrium. The second step estimates the parameters related to the short-run adjustment. The resulting equations are used in conjunction with Granger causality testing and are the following:

$$\begin{bmatrix} \Delta IY_t \\ \Delta SY_t \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix} + \sum_{i=1}^{q} \begin{bmatrix} \beta_{11} & \beta_{12} \\ \beta_{21} & \beta_{22} \end{bmatrix} \begin{bmatrix} \Delta IY_{t-q} \\ \Delta SY_{t-q} \end{bmatrix} + \begin{bmatrix} \lambda_1 \\ \lambda_2 \end{bmatrix} ECM_{t-1} + \begin{bmatrix} u_{1t} \\ u_{2t} \end{bmatrix} \quad (12)$$

where i (i=1,…q) is the optimal lag length determined by the Akaike information Criterion (AIC), ECM_{t-1} is the lagged residual obtained from the long-run ARDL relationship presented in Equations 8 and 9, λ_1, λ_2 are the adjustment coefficients, and u_{1t}, u_{2t} are the disturbance terms assumed to be uncorrelated with zero means $N(0,\sigma^2)$. A significant F-statistic on the first differences of the variables suggests short run causality. Long run causality requires a significant t-statistic on the coefficient of ECM_{t-1} Additionally, joint long-and-short runs causal relationship can be estimated by the joint significance of both ECM_{t-1} and the estimate of lagged independent variables. For instance, β_{11} and $\beta_{12} \neq 0$ shows that national saving Granger causes national investment while Granger causality runs from national investment to national saving is indicated by β_{21} and $\beta_{22} \neq 0$.

2.7 Variance Decomposition Method (VDM)

In time series analysis a variance decomposition method is applied in order to help in the interpretation of a VAR model which has been used. The variance decomposition indicates the amount of information each variable contributes to the other variables in the autoregression. It determines how much of the forecast error variance of each of the variables can be explained by exogenous shocks to other variables.

So, we use forecast error variance decomposition (FEVD) in vector autoregressive (VAR) system to test the strength of causal relationship between national investment to national saving.

The forecast error variance decomposition (FEVD) indicates the magnitude of the predicted error variance for a series accounted for by innovations from each of the independent variable over different time-horizons beyond the selected time period. The main advantage of this approach is that it is not influenced by the time periods of the variables in an autoregressive vector VAR system. Further, this approach can estimate the simultaneous shock affects.

3. Empirical Results

3.1 Unit Root Analysis

Applying the unit root tests of ADF by Dickey and Fuller (1979, 1981), P-P by Philips and Perron (1988) and DF-GLS by Elliott et al. (1996) we present the results on Table 1.

Table 1. Unit root analysis

Variable	ADF		P-P		DF-GLS	
	C	C,T	C	C,T	C	C,T
IY	-1.382(1)	-2.020(0)	-1.802[0]	-2.014[0]	-1.695(0)	-2.212(1)
ΔIY	-6.14(0)*	-6.30(0)*	-6.16[3]*	-6.39[4]*	-4.23(0)*	-5.59(0)*
SY	-1.699(0)	-3.202(0)	-1.496[2]	-3.165[2]	-1.452(0)	-3.3(0)**
ΔSY	-9.89(0)*	-10.1(0)*	-9.89[0]*	-11.3[4]*	-6.30(0)*	-5.96(0)*

Notes. 1. *, ** and *** show significant at 1%, 5% and 10% levels respectively.

2. The numbers within parentheses followed by ADF statistics represent the lag length of the dependent variable used to obtain white noise residuals.

3. The lag lengths for ADF equation were selected using Akaike Information Criterion (AIC).

4. Mackinnon (1996) critical value for rejection of hypothesis of unit root applied.

5. The numbers within brackets followed by PP statistics represent the bandwidth selected based on Newey West (1994) method using Bartlett Kernel.

6. C=Constant, T=Trend.

The results on Table 1 show that variables present unit root at their levels and become stationary at first differences with intercept and intercept and trend. This indicates that the series have unique order of integration I(1).

The results of the unit root tests with structural breaks are given on Table 2.

Table 2. The Zivot and Andrews unit root test results

Variable	Lag lengths [p]	t-statistics	Break year
IY	[0]	-3.436	1994
ΔIY	[1]	-6.072***	1988
SY	[1]	-3.147	2003
ΔSY	[1]	-5.923***	1985

Notes. 1. *, ** and *** show significant at 1%, 5% and 10% levels respectively.

2. The critical values for Zivot and Andrews test are -5.57, -5.08 and -4.82 at 1%, 5% and 10% levels of significance respectively.

The results from Table 2 show that all series present a unit root in their levels with single unknown structural break. Afterwards, all the variables are stationary at first differences accommodating single unknown structural break. This implies that variables are intergrated at I(1).

3.2 Cointegration Analysis

The ARDL cointegration procedure was implemented to estimate the parameters of equations (6) and (7) with the maximum order of lag set to 2 and optimal number of time lags suggested by Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC) and Hannan-Quinn (HQ) criterion, and Likelihood Ratio (LR) criterion (see Pesaran & Shin, 1999).

The results of the aforementioned criteria are presented on Table 3.

Table 3. VAR lag order selection criteria (Max=2)

Lag	LogL	LR	FPE	AIC	SBC	HQC
0	-161.22	NA	128.3847	10.53074	10.62326	10.56090
1	-128.86	58.46533	20.61911	8.700757	8.978303	8.791230
2	-120.47	14.07115*	15.60440*	8.417624*	8.880200*	8.568412*

*denotes the optimal lag selection.

The results from Table 3 show that the optimum lag length on variables equals 2.

The order of lags (q, p) on the first differenced variables for equation (6) was obtained from the minimization of AIC, SBC and HQC criteria (the lag length is used to be 2).

On Table 4 we present the results of these criteria.

Table 4. Order of optimal lags (q,p)

Number of lags	AIC	SBC	HQC
(q=1, p=0)	4.585439	4.770470	4.645754
(q=1. p=1)	4.211915	4.443204	4.287310
(q=2, p=0)	4.560705	4.794238	4.635414
(q=2, p=1)	**4.110539**	**4.390779**	**4.200190**
(q=2, p=2)	4.171615	4.498561	4.276208

Statistics in bold denote the value of the minimized AIC, SBC and HQC.

From the results of Table 4 we can see that all three criteria show that optimal lags on model (6) are q=2, p=1.

Table 5 reports the results of the ARDL bounds testing approach to cointegration.

Table 5. The results of ARDL cointegration test

Bounds testing to cointegration				Diagnostic tests			
Estimated models	Optimal lag length	Structural Break	F-statistics	X^2_{NOR}	X^2_{ARCH}	X^2_{RESET}	X^2_{SERIAL}
F_{IY}(IY/SY)	(2,1)	2007	13.37***	0.427	0.246[1]	4.748[1]	0.520[1]
F_{SY}(SY/IY)	(2,1)	2008	2.310	2.928	0.301[1]	0.094[1]	0.584[1]
Significant level				Critical values (T = 30)			
				Lower bounds I(0)		Upper bounds I(1)	
1% level				10.605		11.650	
5% level				7.360		8.265	
10% level				6.010		6.780	

Notes. The optimal lag length is determined by AIC. [ ] is the order of diagnostic tests. Critical values are collected from Narayan (2005). ***, ** and * show significant at 1%, 5% and 10% levels respectively.

The results of Table 5 show that there is one cointegrating vector (F-statistics seem to exceed upper critical bounds at 1%) confirming the existence of long run relationship among the examined series in the presence of structural breaks. The ARDL models fulfill the assumptions of the diagnostics tests such as normality, autoregressive conditional heteroskedasticity (ARCH), functional forms and serial correlation of models.

3.3 Estimation of the Long and Short Run Relationship

On table 6 the results of long and short run relationships of the variables of our model are presented.

Table 6. Long run results

	Dependent variable = IY_t	
Long run analysis		
Variables	Coefficient	T-statistic
Constant	16.235***	8.693
SY_t	0.342***	3.057
R^2	0.231	
F-Statistic	9.347***	
D-W	0.583	
Diagnostic Test		Probability
X^2 Normal	0.312	0.855
X^2 Serial	16.52[1]	0.000
X^2 ARCH	4.699[1]	0.030
X^2 White	5.964	0.051
X^2 Reset	0.126	0.721
	Dependent variable = ΔIY_t	
Short run analysis		
Constant	-0.469	-1.374
ΔIY_{t-1}	0.664***	3.074
ΔIY_{t-2}	-0.184	-1.123
ΔSY_{t-1}	0.774***	3.492
ECM_{t-1}	-0.424**	-2.563
R^2	0.420	
F-Statistic	4.539***	
D-W	1.645	
Diagnostic Test		Probability
X^2 Normal	0.335	0.845
X^2 Serial	3.385[2]	0.183
X^2 ARCH	1.430[1]	0.231
X^2 White	4.984	0.086
X^2 Reset	4.293	0.038

Notes. ***, ** and * show significant at 1%, 5% and 10% levels respectively. Δ denotes the first difference operator, X^2 Normal is for normality test, X^2 Serial for LM serial correlation test, X^2 ARCH for autoregressive conditional heteroskedasticity, X^2 White for white heteroskedasticity and X^2 Reset for Ramsey Reset test. [ ] is the order of diagnostic tests.

From the results of Table 6 we observe that in the function of investment in the long run, an increase of savings by 1% will increase investments by 0.34%.

In the short run, we can see that savings has a positive sign on investments in 1% level of significance. The negative and statistically significant estimation of ECM_{t-1} by 0.424 show a long run relationship among the examined series of the model. This means that the short run deviations from the long run equilibrium are corrected by 42.4% each year. Finally, the diagnostic tests show that error terms of short run model are normally distributed, and free of serial correlation, heteroskedasticity, and ARCH problem. The Ramsey reset test suggests that functional form for the short run model is well specified.

3.4 Instability Tests

The error-correction model of equation 6 is selected to implement the Brown et al. (1975) stability tests. The related graphs of these tests are presented in Figures 1, 2 and 3.

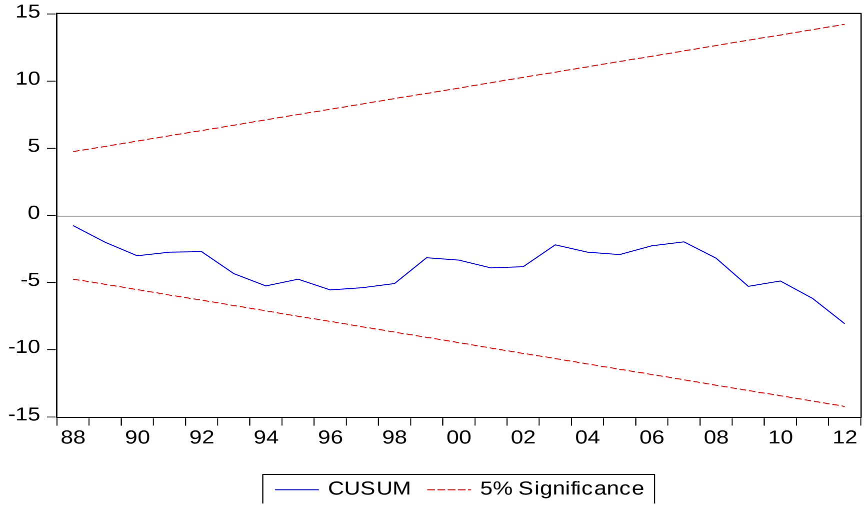

Figure 1. Plot of cumulative sum of recursive residuals

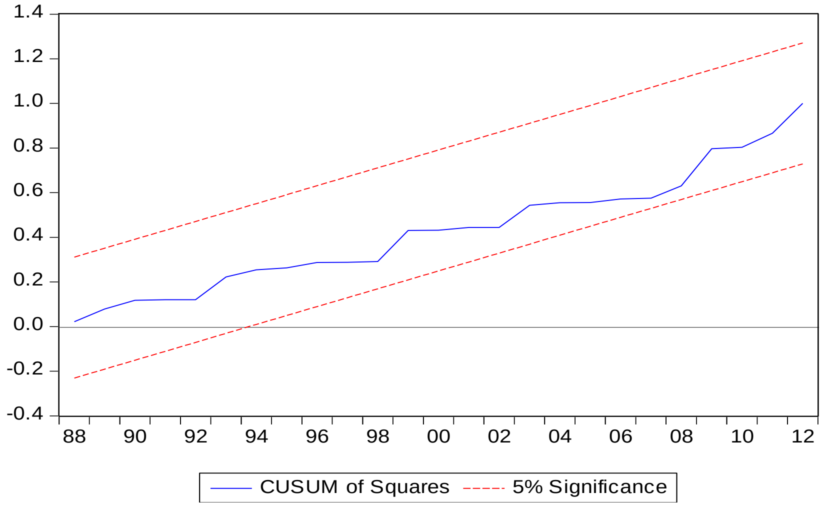

Figure 2. Plot of cumulative sum of squares of recursive residuals

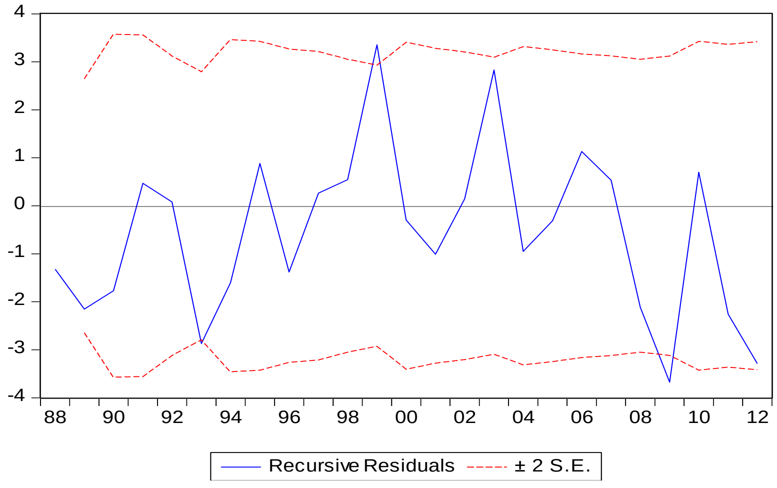

Figure 3. Plot of recursive residuals

As can be seen from the Figures the plots of CUSUM CUSUMSQ and Recursive Residuals statistics are well within the critical bounds at 5% significance level, implying that all coefficients in the error-correction model are stable. Therefore, the selected output model can be used for policy decision making purposes.

3.5 The VECM Granger Causality

Table 7 reports the results on the direction of long and short run causality as well as the strong relation of causality.

Table 7. The ECM-ARDL Granger causality analysis

Dependent variable	ARDL Optimal lag length	Short run (F-stat)		Long run	Strong Causality (X^2)	
		ΔIY_t	ΔSY_t	ECM_{t-1}	ΔIY_t and ECM_{t-1}	ΔSY_t and ECM_{t-1}
ΔIY_t	(2,1)		0.326**	-0.424**		2.758
ΔSY_t	(2,1)	0.214		-0.327	2.567	

***, ** and * show significant at 1%, 5% and 10% levels respectively. Δ denotes the first difference operator.

The results of Table 7 show that both in the short and long run there is a unidirectional causal relationship between savings and investment with direction from savings to investment. Suitable knowledge related to the direction of causality between variables help the government to follow right economic policy.

3.6 Variance Decomposition Method (VDM)

Before we proceed to the presentation of the results of the impulse response functions, it is essential to make sure the VAR models are stable. The chart below shows the Inverse Roots of AR Characteristics Polynomial.

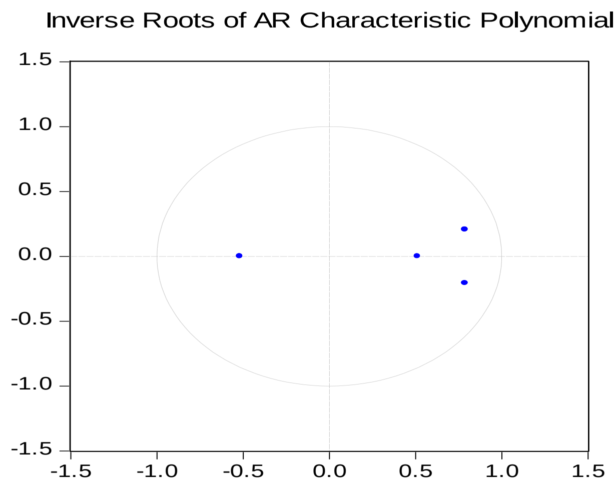

Figure 4. Inverse roots of AR characteristics polynomial

As can be seen from Figure 4, all the roots lie inside the unit circle confirming the stability condition of the VAR models.

The results of variance decomposition approach are described on Table 8.

Table 8. Variance decomposition approach

Variance Decomposition of IY			
Period	S.E	IY	SY
1	1.847206	100.0000	0.000000
2	2.680938	86.14064	13.85936
3	3.011816	88.92306	11.07694
4	3.106390	88.97610	11.02390
5	3.225262	83.00525	16.99475
6	3.410377	74.65089	25.34911
7	3.669050	66.29866	33.70134
8	3.929259	60.58109	39.41891
9	4.154991	57.05048	42.94952
10	4.324193	55.15862	44.84138
Variance Decomposition of SY			
Period	S.E	IY	SY
1	1.988030	14.19967	85.80033
2	2.154135	12.23502	87.76498
3	2.706704	8.003505	91.99650
4	3.129014	9.215906	90.78409
5	3.608534	11.04009	88.95991
6	3.987370	13.67360	86.32640
7	4.287496	15.75051	84.24949
8	4.491361	17.44464	82.55536
9	4.620856	18.62057	81.37943
10	4.693175	19.40758	80.59242

From the results of table 8 we can see that a significant percentage of the variance of investment (86.14%) is explained by investment innovations in the short run (in a horizon of 2 years). On the contrary, a steady variance (13.85%) of saving by (13.85%) is explained by innovations of investment in the short run. In a longer horizon of 10 years the percentage of variance of investment is falling deeply at 55.15% implying that other variables influence the 14% of variance of the investment by 14%. On the contrary, the percentage of variance is considerably increased in the case of savings at 44.84% implying that variations in savings affect approximately 223% of variation in the percentage of variance of investments.

Overall, the findings suggest that domestic private saving and investment are closely related in the long run and that a rise in saving generates higher investment spending.

However the results from the variance decomposition suggest that over the 10 year horizon, a 4.32% of the difference in the error prediction of savings (SY) could be calculate from shocks in the percentage of investment (IY).

The impulse response function is additional of variance decomposition approach and shows the reaction in one variable due to shocks resulting from other variables. Figure 5 plots the impulse responses of saving (SY) and investment (IY) over a horizon of 10 years. Standard errors are calculated by the Monte Carlo method, with 100 repetitions (of ± 2 standard deviations).

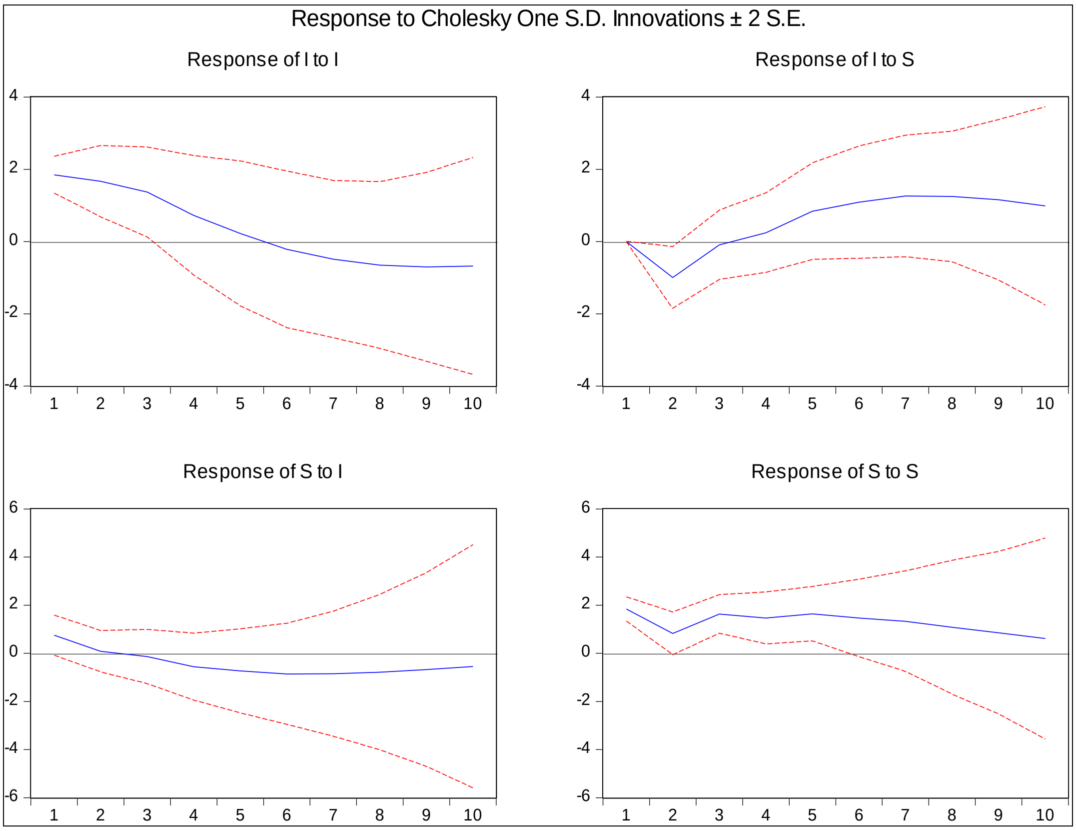

Figure 5. Impulse response function

From Figure 5 we can see that shocks in investments bring reduction in savings in the first two years and then an increase in the next six years. On the contrary, shocks in savings reduce investments the first four years while in the next years investment remains steady.

4. Conclusion and Policy Implications

The increasing interest of researchers for the means leading to high levels and sustainable growth was the underlying motivation behind this study. The link between growth and investments is the main target of all governments worldwide. Nevertheless, the level of success of this target is due to two main conditions. The first is that domestic savings are the main source of available funds for domestic investments because of the limited mobility of funding from abroad. The second condition is that not only should there be a close relation between domestic savings and investments but also the direction of causality between these two variables.

Worldwide, domestic and foreign savings play a vital role in capital accumulation along with national development. Countries' need to gain accessibility to foreign capital enhances the future prospects for sustainable economic growth. For Greece, the most important growth during the 1980's and 1990's was achieved from domestic savings and mainly from capital inputs coming from European Union and private investors. However, the weakness and inefficiency of capital management and the corruption from all governments had as a result the massive flight of capital abroad mainly after 2007. The outputs of capital after 2007 put the country under surveillance to IMF and European Union. As a consequence, investment decreased dramatically, country's growth dropped approximately by 25% during the last years and unemployment reached the highest rates 30% (from the era of Second World War).

On this paper, annual data are used from 1980-2012 for domestic investment and savings, in an effort to find out the validity of the Feldstein-Horioka puzzle as well as the direction of a causal relationship, if there is any, between these two variables. Recent developed econometric methodologies were applied in order to investigate the cointegrated relationships of investments and savings, taking into account the presence of structural breaks in the model. For the detection of structural breaks the Zivot and Andrews (1992) test was used. For testing the long and short run relationship between the two variables, we use the Autoregressive Distributed Lag (ARDL) Model as well as the Error Correction Model (ECM).

Cointegration results show that domestic savings and investments formulate a stable long run relationship with the presence of structural break. The low long run correlation coefficient and the high capital mobility, mainly during the 1980's and 1990's, show that the Feldstein- Horioka puzzle is not valid in the Greek economy. The Augmented Granger causality test show that both in the short and long run, there is a unidirectional causal relationship between savings and investment with direction from savings to investment. Finally, variance decompositions show that domestic savings are the main impetus of investments in a long run basis.

It is widely recognized in the literature that the international capital mobility is of vital importance for increasing investment and growth. The reduction of debt for Greece (either with interest rates reduction, or longer repayment period or debt cuts) will be regarded as the start of new capital input acting as a stimulus for investment, growth's increase, unemployment reduction and people's welfare.

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