GOVERNMENT DEBT IN GREECE: AN EMPIRICAL ANALYSIS

Gisele Mah, Itumeleng P. Mongale*, Janine Mukuddem-Petersen and Mark A. Petersen

Abstract

Greek government debt has been increasing above the percentage stated in the growth and stability path from 112.9% in 2008 to 175.6% in 2013. This paper investigates the determinants of the general government debt in Greek by means of Vector Error Correction Model framework, Variance Decomposition and Generalized Impulse Response Function Analysis. The analysis showed a significant negative relationship between general government debt and government deficit, general government debt and inflation. Shocks to general government and inflation will cause general government debt to increase. Government deficit should be increased since there is gross capital formation included in its calculation which could be invested in income generating projects. The current account balance should be reduced by improving the net trade balance.

Keywords: Sovereign Debt; Greece; Debt crisis; Vector Error Correction Model; Variance Decomposition; Generalized Impulse Response Function.

** School of Economics and Decision sciences, North West University, Mafikeng campus, Private Bag X2046, Mmabatho, South Africa*
Tel.: +27797885240, +2718 389 2620
E-mail: itumeleng.mongale@nwu.ac.za, asmaabdulqahhar@hotmail.com

1. Introduction

African countries experienced the Sovereign debt crisis in the 1960s and 1970s when they accepted loans for political and economic stability from international lenders after their independence. Many of these governments were unable to honour their debts, leading to the formation of the Paris and London Clubs in the 1970s. In 1996, the Highly Indebted Poor Country (HIPC) initiative was created (Callaghy, 2002). The developed economies helped these countries to come out of debt through aids and development assistance. Europe was responsible for half of the aide given to developing countries. In the recent decade, however, most European countries are experiencing a debt crisis themselves. The Eurozone sovereign debt crisis (ESDC) started in 2008 with the collapse of Iceland's banking system and it spread primarily to Greece and Ireland in 2009 and to Portugal in 2011 (Sandoval *et al.* 2011). During this period, several European countries faced the collapse of financial institutions, high government debt and rapidly rising bond yield spreads in government securities. The most affected countries were Portugal, Ireland, Italy, Greece and Spain, collectively referred to as the PIIGS group.

Greece had a sovereign debt rate of 112.9% in 2008 and 175.1% in 2013. According to AMECO; this value is measured by the ratio of total government debt to GDP. This rising level of debt started building up from 1970 with the first and second oil shock. According to Alogoskoufis (2012), by 1997, a growth and stability pact was adopted by 27 member states of the European Union (EU) which aimed to maintain fiscal discipline and was reformed in 2005. The criterion of 3% budget deficit to GDP ratio and a 60% national debt to GDP ratios were maintained. In late 2000, the Greek economy was affected by the slowdown of the world economy which had an effect on its shipping and tourism industry, hence accumulating its national debts. By 2002, when it adopted the Euro as a currency, it had access to loans at low interest rate and also low bond rates in the Eurobond market. This resulted in increasing consumption spending.

As Arghyrou and Tsoukalas (2010) mentioned, the USA subprime mortgage crisis and the 2007-2008 financial crisis slowed down the growth rate in Greece to 2%, while the economic recession in 2009 affected access to credit, world trade and domestic consumption. Subsequently, Greece was excluded from the international financial markets in April 2010. On the 2 May 2010, it got a bailout package of €110 billion (Anand et *al*., 2012 and Calice *et al*., 2013) and the second bailout package of €130 billion in 2012 (Castel, 2012). By June 2012, Greece has undergone five series of austerity measures in order to reduce deficit spending and increase taxes.

The main concern was that if Greece defaults, it will lead to loss of confidence by investors and the downgrading of the credit rating of the PIIGS countries. Moreover, if it defaults on its debt, the

banks of countries that provided the debt will face a tremendous liquidity problem which will lead to low production, less development, reduced trade and a situation leading to global economic depression. The Greek sovereign debt crisis makes their funding difficult and costly to have. It increases interest rates, export prices, depreciation of the Euro, and increase in unemployment, reduction in remittances sent to developing countries and a tightening of fiscal policy. As a result the austerity measures have affected citizens to an extent that it has lowered their standard of living due to increase in taxes, decrease in salaries and bonuses and an increase in unemployment and privatization. Furthermore, much money is spent on external debt services; as a result this reduced savings and foreign exchange earnings that could have been used to invest in the economy. The irony is that Greece and other European countries experiencing the crisis, used to give aid and development assistance to the developing countries. The implication is that they will not be able to assist and this will affect developing countries negatively in terms of the aid.

The recent wide spread of unsustainable debt in developed economies culminated in the Eurozone sovereign debt crisis, and this phenomenon with special reference to the Greek case was the main motivation for the study reported in this article. Based on the review of related studies and the economic theory, this paper is aimed at identifying the main reasons why Greece has been recording very high levels in its sovereign debt. The above background culminated in the question: What could be the possible determinants of the rising government debt in Greece?

The search for an answer to this question was based on the conceptual and theoretical framework that is outlined in Section 2. The outline of the framework is followed by the empirical investigation in Section 3. Section 4 presents the findings and discussion of the study. The article ends with some conclusions and a recommendation in Section 5.

2. Theoretical framework and Literature review

Government debt is defined by Black *et al.* (2012) as the sum of all outstanding financial liabilities of the government whereby it has the responsibility to repay the principle debt and the debt servicing. It seems that many developed countries are experiencing rising debt to the point where they have gone above the 60% ratio to GDP stated in the growth and stability path. These highly indebted countries including Greece are therefore experiencing Sovereign debt crisis.

The Keynesian economists are of the point of view that deficit spending could be as a result of increase in government expenditure or decrease in taxes and the performance of the economy. Their premise is that during a recession, fiscal policy is appropriate to bring the economy out of recession. That been the case, they are criticized because it is relatively easy to increase budget deficit and public debts in periods of economic recession, but it is rather difficult to reverse the trend during a recovery. Furthermore, the economic problems of most countries are structural rather than cyclical in nature, so debt financing has less ability to stabilize the economy from the macroeconomic point of view (Black *et al.*, 2012). Keynes encourages public borrowing which is a short term fiscal policy measure that will stimulate the economy hence bringing the economy out of recession.

On the other hand the neoclassical economists saw government deficit as a structural deficit and mentioned that it affects interest rates on private investment. Deficit occurs when government borrows from the public or foreign sources to finance its expenditures. When government competes with other borrowers to borrow funds, this causes an upward pressure on interest rates which crowd out private investors who are competing for the same funds. In the long run, deficit reduces the stock of private investment, hence economic growth. But if the government invests the borrowed funds, it produces capital and the burden of debt on future generations is reduced. When funds to finance the deficit are obtained from abroad, it becomes an additional debt serving problem since debt interest has to be paid alongside the principal amount. This constitutes a transfer from domestic country to individuals living abroad thus affecting the domestic citizens.

Deficits put pressures on the government which may make the monetary authority to monetize the debt which will eventually cause money supply to increase hence causing inflation in the economy. Also, a large deficit may cause government to default. Therefore the Neoclassical economist believes that when the government borrows from the country itself or abroad, it affects the economy of the country. The Inter-temporal budget constraint (IBC) is examined at its theoretical base. The IBC requires that the total government spending must be within the funds available for it over a long period. According to Salvi (2011), the IBC starts with a public sector income statement with one period budget constraint which explains the evolution of the net debt as

$$B_{t+1} = (1+r)B_t - PB_{t+1} \quad (1)$$

where B_t is the stock of public net debt, r is the interest rates and PB_t is the difference between revenue and expenditure excluding interest expenditure. The IBC is

$$B_t = \sum_{t=1}^{\infty} (1+r)^{-i} PB_{t+1} \quad (2)$$

However, Bohn (2005) disagrees with the IBC in sustainability analyses and introduces the Model-Based sustainability (MBS) since it generalises the IBC to a world of uncertainty. It is assumed that the creditors are optimizing agents so that the government does not have a negative debt in the long run and that financial markets are complete. The model based sustainability criterion is

$$B_t = \sum_{n=0}^{\infty} E_t(U_{t,n} PB_{t+n}) \quad (3)$$

where $U_{t,n}$ of the economy is the pricing kernel for contingent claims and PB_t is the difference between revenue and expenditure excluding interest expenditure. This theory is in line with this study because the budget deficit is a determinant of sovereign debt. Consequently the IBC is adopted in this study to explain the determinants of government debt in Greece and the model was adjusted by introducing the current account balance, inflation and government savings.

3. Empirical investigation

The Vector Error Correction Model (VECM) was constructed to analyse both short and long run relationships between the Greek Sovereign debt and its determinants. The variance decomposition and the Generalized Impulse Response Function (GIRF) are used to evaluate the impact of shocks on the Greek Sovereign debt levels. When we apply these tests, we expect to get a good debt determinant model for Greece.

3.1 Data

The study uses annual data from 1976 to 2010 obtained from AMECO, world development indicators (WDIs) and the IMF. In line with studies such as Oh and Lee (2004) who used annual data from 1970 to 1999, Chakluk (2000) had 32 observations, while Babatunde and Adebafi (2005) had 33 observations, therefore, a period of 34 years data is considered to warrant a sound conclusion in this study. This implies that the 34 observations for our study were sufficient for a VECM analysis. Government deficit was contracted by subtracting gross national expenditure from gross national income and all the other variables were used without adjustments. The independent variables are government deficit (GDEF) in millions, current account balance (CAB) in % of GDP, inflation (INF) in annual % and government savings (GSAV) in % of GDP while the dependent variable is general government debt (GDEBT) in % of GDP. The debt determinant model for Greece in natural logarithmic form is expressed as:

$$In(GDEBT_t) = \beta_o + \beta_1 In(GDEF_t) + \beta_2 In(CAB_t) + \beta_3 In(INF) + \beta_4 In(GSAV) + \varepsilon_t \quad (4)$$

and it is in line with the classical linear regression model.

3.2 Estimation techniques

Stationarity Test: Phillip Perron (PP) and Augmented Dickey Fuller (ADF) tests were conducted at constant and trend only. When variables are nonstationary at level form, stationarity test are carried out at first difference.

The test of ADF is given as

$$\Delta Y_t = \alpha + \beta t + \delta Y_{t-1} + \sum_{i=1}^{n} \lambda_i \Delta Y_{t-1} + \varepsilon_t \quad (5)$$

When we fail to reject the null hypothesis we conclude that the variables are nonstationary, Dickey and Fuller (1981).

The Phillip and Perron (1988) test regression is as follows

$$\Delta Y_t = \beta_0 X_t + \alpha Y_{t-1} + U_t \quad (6)$$

The PP test was considered here because the requirements of the homoskedasticity assumption is not needed in the error term and there is correction of serial correlation and autoregressive heteroskedasticity in the error terms (Drisaki, 2013). Moreover, PP tests consider less restriction on the distribution of the disturbance term (Enders, 1995).

Descriptive statistics: A brief description of our variables using measures of central tendency and measures of variability was done. The Jaque-Bera statistics shows the variables that satisfy the normality test at level form (Gujarati & Porter, 2009).

Determination of lags: There are various criteria for selecting the appropriate lag length such as Akaike information criterion (AIC), Schwarz information criterion (SC), and Hannan-Quinn information criterion (HQ). According to Liew (2004), the AIC and the FPE results are superior when observations are sixty and below than the SIC and HQ criterion when wanting to have a good lag length criteria.

Johansen cointegration test: According to Chang and Carballo (2011), the Johansen technique permits us to have more than one cointegrating relationships as contrary to Engle Granger which gives just one cointegrating equation. The Johansen methodology starts from the Vector autoregression (VAR) as:

$$\Delta Y_t = \mu + \prod Y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-1} + \varepsilon_t \qquad (7)$$

The Johansen test proposes two different likelihood ratio tests of the significance of these canonical corrections and the reduced rank of the $\prod$ matrix. There exist an n×r matrix α and β of the reduced rank where α represents the adjustment parameters and β is the cointegrating vector. There are two types of Johansen test: the trace and the maximum eigen value and the inference might be a little bit different. The trace test and the maximum eigen value test are as follows:

$$J_{\text{trace}} = -T \sum_{i-r+1}^{n} \text{In}(1-\bar{\lambda}_i) \qquad (8)$$

$$J_{\max \text{Egen}} = -T\text{In}(1-\bar{\lambda}_{r+1}) \qquad (9)$$

where T is the sample size and $\bar{\lambda}$ is the i^{th} largest canonical correlation.

Weak exogeneity test: Bonham et al. (2009) mentioned that this test addresses the problem of over parameterization found in the VECM, that is , many equations in the system will be reduced to one and the number of parameters by ($mk+d$) where d is the number of deterministic component. According to Johansen (1991), when β' are cointegrating vector, x_t is weakly exogenous when $\alpha_x = 0$.

Long run restriction test: We imposed restrictions on β to get a good representation of our long run cointegrating equation from our VECM (Hall et al. 2002). Restrictions were imposed using economic theory point of view.

VECM: This test shows the long run component of our variables and the short run flexible dynamic specification. A proportion of the disequilibrium from one period is corrected in the next period. VECM involves estimating the model in the first difference form and adding an error correction term as an explanatory variable (Meniago, et al, 2013). The dynamic error correction can be obtained by using the autoregressive distributed lags approach. The error correction term (ECT) values are obtained by conducting a regression on the dependent variables with all the independent variables in the model.

Variance decomposition test: According to Enders (2010) Vector Moving Average (VMA) is

$$y_t = \mu + \phi_1 y_{t+1} + ... + \phi_p y_{t+2} + \varepsilon_t \qquad (10)$$

where focus was on y_t, the n-step ahead forecast error is

$$y_{t+n} - E(y_{t+n}) = \phi_{11}(0)\varepsilon^s y_{t+n} + \phi_{11}(1)\varepsilon^s y_{t+n-1} + ...\phi_{11}(n-1)\varepsilon^s y_{t+1} \qquad (11)$$

$$\phi_{12}(0)\varepsilon^s x_{t+n} + \phi_{12}(1)\varepsilon^s x_{t+n-1} + ...\phi_{12}(n-1)\varepsilon^s x_{t+1} \qquad (12)$$

Generalized Impulse Response Function (GIRF): Instead of the Impulse Response Function (IRF), we employ the GIRF because the IRF possess several inconveniences. The IRF is sensitive to the ordering of variables and the omission of important variables in the system may lead to wrong results. In lieu of this, we utilized the GIRF proposed by Koop, Pesaran and Potter (1996) which is represented as follows

$$GI_x(h,\sigma,\lambda_{t-1}) = E\left[X_{t+h} \mid \varepsilon_t = \sigma, \lambda_{t-1}\right] - E\left[X_{t+h} \mid \lambda_{t-1}\right] \qquad (13)$$

where σ is the known vector. The

$$GI_x(h,\sigma,\lambda_{t-1}) = C_h\sigma \qquad (14)$$

is a VAR which dependent on λ_{n-1} but depends on the composition of the shocks defined by σ .

4. Findings and Discussions

The following results have been considered at a 5% level of significance in deciding whether to reject or accept the null hypothesis.

4.1 Unit root test results

The stationarity test result in Table 1 shows that all the variables are stationary at first difference I(1). The null hypothesis of no unit roots was rejected at first differences since both the ADF and PP test statistics values are less than the critical values. The PP test gives more accurate results than the ADF test since it is non-parametric and is based on asymptotic theory (Mahadeva and Robinson, 2004).

Table 1. Unit root test of time series with ADF and PP tests at intercept and trend

	ADF TEST			PP TEST			
Variables	T-values (Lags)	5% Critical value	SIC	T-values (Bandwidth)	5% Critical value	SIC	Order of integration
LGDEBT	-5.520218***(0)	-3.552973	-2.119930	-5.525131***(2)	-3.552973	-2.119930	I(1)
LGDEF	-9.705376***(0)	-3.552973	1.835456	-32.77721***(32)	-3.552973	1.835456	I(1)
LCAB	-7.608637***(0)	-3.552973	1.960600	-11.89895***(18)	-3.552973	1.960600	I(1)
LINF	-8.288442***(0)	-3.552973	0.919419	-8.234738***(1)	-3.552973	0.919419	I(1)
LGSAV	-0.886233(2)	-3.562882	-1.218880	-7.422549***(4)	-3.552973	-1.090785	I(1)

Note: Reject at 10 %(*), 5 %(**), 1 %(***) significant level

4.2 Descriptive statistics results

The mean, median, mode, minimum and maximum values of our variables were close to each other as shown in Table 2. This indicates that the data is symmetric. The null hypothesis states that residuals of the variables at level form are normally distributed. The residuals from LGDEBT, LGDEF, LINF and LCAB could not be rejected at 5 % level of significance as indicated by the high p-value of the Jaque-Bera statistics; therefore, we accept the null hypothesis that the residuals from these variables are normally distributed. Hence in testing for stationary of such variables, structural break and outliers will not have to be accounted for when using the conventional unit root test. Nevertheless, the residuals of LGSAV are rejected at 5%, thereby indicating that this variable is not normally distributed at level.

Table 2. Descriptive statistics of variables used in the study at level form

NAME OF VARIABLES	LGDEBT	LGDEF	LCAB	LINF	LGSAV
MEAN	4.167903	-8.937578	-1.648621	2.143874	2.865577
MEDIAN	4.552392	-9.014565	-1.566322	2.498974	2.961037
MAXIMUM	4.976506	-5.987710	-0.123102	3.213863	3.451637
MINIMUM	2.875371	-10.51586	-2.775023	0.190620	1.532125
STD. DEV.	0.622117	1.125359	0.597078	0.843808	0.404573
SKEWNESS	-0.842018	0.768060	0.192176	-0.427689	-1.430044
KURTOSIS	2.333658	2.985765	3.027121	1.889965	5.164231
JARQUE-BERA	4.783319	3.441474	0.216507	2.863947	18.76000
PROBABILITY	0.091478	0.178934	0.897400	0.238837	0.000084
SUM	145.8766	-312.8152	-57.70175	75.03559	100.2952
SUM SQ. DEV	13.15900	43.05873	12.12106	24.20841	5.565105
OBSERVATIONS	35	35	35	35	35

4.3 Lag length selection criteria results

The results in Table 3 show the best selected lag by the AIC, HQ, LR and FPE criterion. All other tests will be conducted using the chosen lag length of 2, in order to get a good model that reveals the determinant of rising debt in Greece.

Table 3. Lag length criteria at level for this study

LAG	LOGL	LR	FPE	AIC	SC	HQ
0	-80.68352	NA	0.000124	5.192941	5.419684	5.269233
1	46.35046	207.8738	2.61e-07	-0.990937	0.369524*	-0.533183
2	78.23372	42.51101*	1.92e-07*	-1.408104*	1.086075	-0.568889*

** indicates lag order selected by the criterion.*

4.4 Cointegration results

We analysed cointegration with Johansen using the trace statistics and the maximum eigen statistics. Table 4 shows that there is one cointegrating equation since the maximum eigen statistics are better than the trace statistics (Lutkepol et *al*., 2001). The results show that in the case of the trace tests, the null hypothesis of no cointegrating vectors was rejected since the test statistics of 102.8624 is greater than the 5 % critical value of 69.81889, hence cointegration exists at none. Moving on to the test of the null hypothesis of at most 1 cointegration vector, the trace statistics of 48.16393 is greater than the critical value of 47.85613, hence cointegration exist. The trace statistics of 24.90181 of at most 2 is less than the critical value of 29.79707; therefore the null hypothesis of no cointegration is accepted. The probability of the trace statistics was only significant at none and at most 1 hence confirming that two long run relationships exist between our variables.

At none, the maximum eigen value statistics of 54.69851 is greater than the critical value of 33.87687. However, the maximum eigen statistics values of at most 1, 2, 3 and 4 are less than that of 5 % indicating that the null hypothesis of no cointegration vector was accepted. The probability of the maximum eigen test is significant only at none hence confirming the existence of one cointegration relationship among the variables. As the maximum eigen test tend to be more appreciated than the trace test, we conclude that there is one cointegrating equation in the system. This means that there was a unique long run relationship between LGDEBT and its determinants in Greece.

Based on the normalised cointegrating coefficients the long run regression is expressed as follows:

$$LGDEBT = -374485LGDEF + 0.626167LCAB - 0.380628LINF - 0.422749LGSAV \quad (15)$$

We explained this long run equation under the VECM estimates which gave the same result and had the level of significance of our variables.

Table 4. Cointegration results

Hypothesized No. Of CE(S)	EigenValue	Trace Statistic	0.05 Critical Value	Probability	Max-Eigen Statistics	0.05 Critical Value	Probability
NONE	0.819013	102.8624	69.81889	0.0000	54.69851	33.87687	0.0001
AT MOST 1	0.516615	48.16393	47.85613	0.0468	23.26212	27.58434	0.1626
AT MOST 2	0.369859	24.90181	29.79707	0.1650	14.77797	21.13162	0.3047
AT MOST 3	0.265426	10.12384	15.49471	0.2713	9.870863	14.26460	0.2205
AT MOST 4	0.007874	0.252976	3.841466	0.6150	0.252976	3.841466	0.6150

4.5 Weak exogeneity test

The weak exogeneity test is performed to help to identify if variables are to be considered weakly exogenous to the system (Meniago et al., 2013). As seen in Table 5, the results confirm that at the 1% significance level, all the variables are not weakly exogeneous to the system, thus endogenous. Hence our variables are independent off all other responses values.

Table 5. Results of the Weak exogeneity tests

VARIABLES	CHI-SQUARE	PROBABILITY
LGDEBT	41.42121	0.000000
LGDEF	36.45597	0.000000
LCAB	39.35416	0.000000
LINF	41.40933	0.000000
LGSAV	39.68111	0.000000

4.6 Long run restriction test

The results of the long run restriction test in Table 6 reveal that correct restrictions signs are imposed on the variables according to the theory in our model hence it gives a good long run equation. These results also confirms that the signs of the restrictions were correctly specified since the probability value was highly significant at 1 % level; therefore we imposed these restriction signs on our variables to get a good long run equation which reveals correctly the determinants of rising debt in Greece.

Table 6. Results of restrictions on β

VARIABLES	CHI-SQUARE	PROBABILITY
LGDEBT - LGDE F+ LCAB + LINF – LSAV	44.82945	0.000000

4.7 VECM estimates results

Since our variables are in natural logarithms, the coefficients were interpreted as long run elasticities (the degree to which a change in our dependent variable from a unit change in our independent variables).

4.7.1 Long run estimates

The long run relationship of our model is

$$LGDEBT = 3.900687 - 0.374485LGDEF + 0.626167LCAB - 0.380628LINF - 0.422749LGSAV \quad (16)$$

The VECM estimates results of the long run relationship shows that there was a significant negative relationship with LGDEBT and LGDEF. A 1% increase in LGDEF will cause LGDEBT to decrease by 0.374%. This negative relationship could be as a result of the gross capital formation included in the LGDEF calculations.

LGDEBT and LCAB show a significant positive relationship hence 1% increase in LCAB will significantly cause LGDEBT to increase by 0.626%. A significant negative relationship was revealed between LGDEBT and LINF. If LINF increases by1%, LGDEBT will decrease by decrease by 0.381%. LGDEBT and LGSAV show a negative relationship hence a 1% increase in savings would cause LGDEBT to decrease by 0.423%. Therefore the main determinants of rising government debt in Greece are current account balance and inflation.

Table 7 shows that the error correction term (ECT) is significant with the exception of LGSAV. This provides an additional evidence of cointegration in the government debt function of Greece. The estimate of the equation is theoretically correct since the sign of ECT is negative (-0.209504) and with a high absolute t-statistics value of 2.31702. The ECT was expected to be negative for equilibrium to be restored. This confirms that there was a problem in the long run equilibrium relationship between the dependent and the independent variables. The adjustment of the model of the previous year's disequilibrium is 20.1%.

Table 7. Long run coefficient and level of significance

Variables	LGDEBT	LGDEF	LCAB	LINF	LGSAV	Constant
Coefficient	1.000000	0.374485	-0.626167	0.380628	0.422749	-3.900687
t-statistics		6.57749	-10.4168	7.68836	1.60907	
Variables		D(LGDEBT)	D(LGDEF)	D(LCAB)	D(INF)	D(LGSAV)
Error correction term		-0.209504	-1.508414	1.061339	-1.274131	0.219859
T statistics		2.31702	-2.23138	2.36210	-3.47374	1.42841

4.7.2 Short run results

The coefficient of changes in lag 2 of LGDEBT, LGDEF and LGSAV are negative and insignificant as shown in Table 8. The negative sign shows that they have negative effect in the short term changes in LGDEBT. Since it is insignificant, the value does no matter that much. The coefficient of changes in lag 2 of LCAB and LINF are positive and LCAB is significant while LINF is insignificant. The positive sign implies that they have positive effects on LGDEBT in the short term changes of LGDEBT. Since all variables are insignificant except LCAB at lag 2, we conclude that only LCAB does affect LGDEBT in the short run. The R square has a value of 0.632702 implying that about 63% of variation in LGDEBT is explained by the independent variables in Greece.

After estimating the model, we conducted stability and diagnostic tests to determine if the model was stable throughout the period.

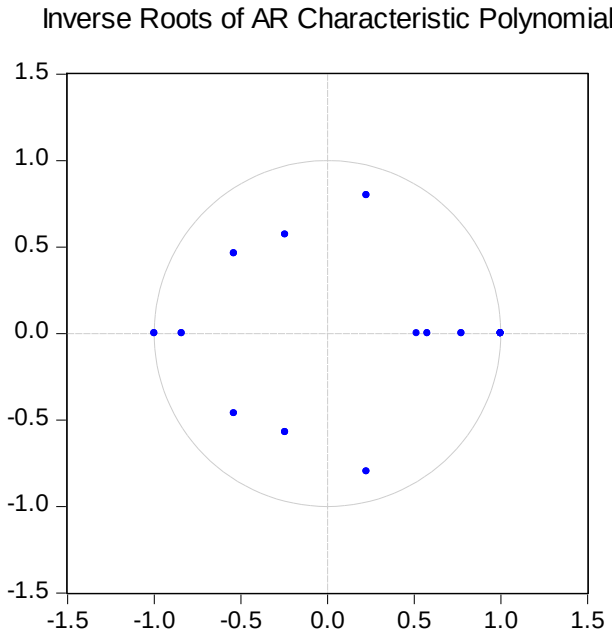
Table 8. Short run Error Correction results

Variables	Coefficient	T statistics
CointEq1	0.209504	2.31702
D(LGDEBT(-1))	0.085639	0.46185
D(LGDEBT(-2))	-0.085871	-0.42496
D(LGDEF(-1))	-0.032192	-1.06179
D(LGDEF(-2))	-0.022569	-0.87671
D(LCAB(-1))	0.043246	0.92369
D(LCAB(-2))	0.098875	2.08032
D(LINF(-1))	-0.063577	-1.25339
D(LINF(-2))	0.050249	0.77841
D(LGSAV(-1))	-0.189808	-1.45207
D(LGSAV(-2))	-0.068908	-0.48636
R-squared	0.632702	
Adj. R-squared	0.520688	

4.7.3 Stability test results

The AR roots was used to test the stability of the model and Figure 1 shows that all the unit roots lie in the unit circle indicating that the model is stable. The suggestion is that further analysis could be carried out since the model is stable and it can be acceptable in explaining the determinant of government debt in Greece.

Figure 1. Stability test results



4.7.4 Diagnostics test

The diagnostic tests indicate that the model has no heteroskedasticity, no serial correlation, and it is also normally distributed as shown in Table 9. It means that our estimated model is good and can be interpreted for policy analysis. We then we can proceed to forecasting.

Table 9. The summary of diagnostics and stability tests results of our regression

Test	Null Hypothesis	Test statistics	P- value	Conclusion
AR roots graph	Stable model	$\sum_{i=1}^{n} a_i < 1$		The model is stable
Autocorrelation LM test	No serial correlation	At lag 2, LM stat=26.40175	0.3864	There is no serial correlation
White	No heteroskedasticity	Chi square = 356.4155	0.1520	There is no heteroskedasticity
Jarque Bera	Residual are normally distributed	JB = 8.473953	0.5826	The model is normally distributed

4.8 Variance decomposition results

Table 10 shows how much of the predicted error variance can be explained by the exogenous shocks of other variables. The table is a summary of variance decomposition results of LGDEBT on the independent variables over a period of ten years. At the end of 10 years, the forecast error variance of LGDEBT is explained by its own innovations with 93.76%. During the second period, LCAB is the only variable that explains the highest variation in LGDEBT with 2.6% and during the third period, LINF is the highest explanatory variable with 1.99% followed by LCAB in the 4th period with 2.4%. From the 5th to the 10th period, LINF explains the variation in LGDEBT with up to 4.02%. It appears that the variations in LGDEBT in Greece over the years are highly caused by LGDEBT, followed by LCAB in the second and fourth period and LINF over the remaining periods.

The results further reveal that from the variance decomposition of LGDEBT on LGDEF, a high proportion of shocks are explained by their own innovations with 84.88 % followed by a small 3.74 % of LGDEBT. The variance decomposition of LGDEBT on LCAB is mostly explained by LGDEBT with a 42.31 % followed by itself with a 17.575 variation in its own innovation. The variance decomposition of LGDEBT on LINF is 55.96% by itself, followed by 29.07 of LCAB. LGDEBT on LGSAV is 55.43% on itself, followed by 30.48 by LINF. We conclude that apart from LCAB, most of the variations are explained by their own innovations. Any shock in the economy will be explained by the chosen variables itself.

Table 10. Variance decomposition results of LGDEBT on our independent variables

Period	S.E	LGDEBT	LGDEF	LCAB	LINF	LGSAV
1	0.067006	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.115295	96.14786	0.028037	2.608841	0.459410	0.755847
3	0.149169	94.92303	0.115419	1.960608	1.993853	1.007090
4	0.193727	94.56275	0.102519	2.405121	2.242248	0.687360
5	0.238024	93.62563	0.195698	2.700015	3.012058	0.466598
6	0.278575	94.02228	0.150664	2.499837	2.970478	0.356737
7	0.317792	93.92581	0.119690	2.162626	3.509744	0.282126
8	0.354696	93.98535	0.097667	2.104196	3.565022	0.247761
9	0.390214	93.69548	0.083998	1.958639	4.057045	0.204837
10	0.424915	93.75892	0.080623	1.965439	4.020301	0.174715

4.9 Generalized Impulse Response Results

Result shows that the shock of LGDEBT to LGDEBT is positive, LGDEBT to LGDEF is negative, LGDEBT to LCAB is negative, LGDEBT to LINF is positive and LGDEBT to LGSAV is negative. While the shock of LGDEF to LGDEBT is fluctuating between positive and negative it is more negative; LCAB to LGDEBT is negative and then positive from the second till the tenth period. LINF to LGDEBT is positive and finally LGSAV to LGDEBT is negative and then positive from the fourth to the tenth period. This means that a shock from LGDEBT will cause an increase in LGDEBT. A shock from LGDEF, LCAB and LGSAV will cause a decrease in LGDEBT, while a shock from LINF will cause an increase in LGDEBT. LGDEF, LCAB and LGSAV

determine government debt in Greece and react negatively to it.

5. Conclusions and policy recommendations

There is a significant negative relationship between general government debt and government deficit, and general government debt and inflation. Similarly there is a significant and a positive relationship between general government debt and current account balance and a negative but insignificant relationship between general government debt and gross savings. Therefore the main determinants of government debt in Greece are: government deficit, inflation and current account balance.

Variance in general government debt was mostly explained by general government debt itself. It also appears that current account balance and inflation cause the highest variation in general government debt over the periods. The response of general government debt to general government debt is positive and that of general government debt to government deficit and general government debt to current account balance is negative. On the other hand, the response of general government debt to inflation initially has no effect until after the second periods where it becomes positive. A shock of general government debt to gross savings appears to be negative in Greece. Policy makers in Greece should therefore be willing go into more deficits, using the deficit to invest into income generating investments. This is likely to help to reduce the Government debt in future as postulated by Keynesian theory. The current account balance should rather be reduced while inflation is increased. Finally it seems that the fiscal, monetary and trade policy are the best policies to be implemented to reduce the rising government debt in Greece.

Acknowledgements

The authors wish to acknowledge the support in terms of training in Time series from Economic Research Southern Africa (ERSA).

References

1. Alogoskoufis, G,(2012), Greece's sovereign Debt Crisis: Retrospect and Prospect. *Hellenic observationary European Institute, papers on Greece and Southeast Europe, GreeSE* paper. 54.
2. Akram, M., Ali L., Karamat M. & Noreen H. (2011), The Greek Sovereign debt crisis: Antecedents, consequences and reforms capacity. *Journal of Economics and Behavioural Studies*, Vol 2 No 6 pp.36 – 318.
3. Anand, M.R., Dash R., Gupta G.L.(2012), The Eurozone crisis: its dimensions and implications. *Economic Division in the Department of Economic Affairs and Ministry of Finance of Indian.*
4. Arghyrou, G.M. & Tsoukalas, D.J. (2010), The Greek debt crisis: likely causes, mechanics and outcomes (Cardiff Economics Working Papers E2010/3). April 2010.
5. Armanious, R.N.A. (2011), The sovereign debt crisis in EU and MENA: Mechanisms and challenges. http://www.med-eu.org/documents/MED4/Dossier%201/ARMANIOUS.pdf. Date of access: 11 April. 2012.
6. Armingeon, K. & Baccaro, L. (2011), The Sorrows of Young Euro: Policy responses to the sovereign debt crisis. Retrieved February 20, 2012 from http://www.unige.ch/ses/socio/rechetpub/dejeuner/dejeuner20112012/thesorrowsofyoungeuro.pdf.
7. Artus, P. (2010), Likely consequences of the sovereign debt crisis in the Eurozone. Economic Research, Flash Economics.
8. Asteriou D. & Hall C.G. (2007), *Applied Econometrics: A modern Approach using Eviews and Microfit Revised Edition*. Palgrave Macmillan.
9. Babatunde A. M. & Adefabu A. R. (2005), Long run relationship between Education and Economic growth in Nigeria: Evidence from the Johansen's cointergration Approach. Paper presented at the Regional conference on Education in West Africa: Constraint and opportunities Dakar, Senegal, Nov 1st to 2nd 2005.
10. Bonham C., Gangnes B. & Zhou T. (2009), Modelling tourism: A fully identified VECM approach, *International journal of forecasting*, Vol. 25, pp. 531 - 549.
11. Budina N., Fiess N. et al. (2005), Public sector debt and its determinants in market access countries. Results from 15 countries case studies. World Bank, March 2005. Retrieved on April 27 2012 from http://siteresources.worldbank.org/INTDEBTDEPT/Resources/468980-1225740508953/MACCaseStudiesMar05.pdf.
12. Calice, G., Chen, J. & Williams, J. (2013), Liquidity spill over in sovereign bond and CDS markets: An analysis of the Euro Zone sovereign debt crisis. *Journal of Economics Behaviour and Organisation*, Vol.85, pp.122-143
13. Castle, S. (2012), With details settled, a second Greek Bailout is Formally Approved. The New York Time Retrieved March 20. 2012 from http://www.nytimes.com/2012/03/15/business/global/greece-gets-formal-approval-for-second-bailout.html?_r=1.
14. Chang C. & Carballo S.E.C. (2011), Energy conservation and sustainable economic growth: The case of Latin America and the Caribbean, *Energy policy*, Vol.39, No.7 pp.4215-4221.
15. Chawluk, A. (2000), Estimate of demand for money and consumption functions for the house hold sector in Poland, 1967- 1999. University of Oxford, department of Economics discussion paper series no. 42, ISSN 1471-0498.
16. Checherita, C. & Rother, P. (2010), The impact of high and growing government debt on economic growth, An empirical investigation for area. (European Central Bank Working Paper Series no. 1237), August 2010.
17. Dickey D. & Fuller, W.A. (1981), Likelihood Ratio Statistics for Autogressive Time Series with a Unit Roots, *Econometrica* Vol.49 No. 4, pp. 1057-1072.

18. Dritsaki, C. (2013), Causality Nexus between economic growth, exports and government debt: The Case of Greece. International conference an applied economics, prodedia economics and finance, 5(2013)251-259.
19. Enders W. (2010), *Applied econometric time* series 3rd edition. Wiley and sons Inc, Hoboken.
20. Engle, R.F., Granger, C.W.J., (1987), Cointergration and Error Correction: Representation, Estimation and Testing, *Econometrica*, Vol. 55 No.2, pp. 251-276.
21. Estenssono, A. (2010), European sovereign debt remains largely a European problem, Contagion risk. The Regional Economist. http://www.stlouisfed.org/publications/re/articles/?id= 2017. Data access on 19 March. 2012.
22. Gujarati D.N. (2004), *Basic Econometrics Forth Edition*. The Mcgraw-Hill, New York.
23. Gujarati D.N, Porter D. (2009), *Basic Econometrics5th edition*. McGraw Hill international edition, New York.
24. Johansen, S. (1998), Statistical analysis of cointegration vectors, *Journal of Economics Dynamics and control*, Vol. 12 No.2-3, pp. 231-254.
25. Johansen, S. (1991), Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models, *Econometrica*, Vol.59 No. 6, pp. 1551-1580.
26. Johansen, S. (1995), Likelihood-*based inference in cointegrated vector autoregressive models*, Oxford University Press, London.
27. Hall, S.G., Henry,S. & Greenslade, J. (2002), On the identification of cointegrated systems in small samples: A modelling strategy with an application to UK wages and prices, *Journal of Economic Dynamics and control*, Vol.26 No. 9-10 ?, pp. 1517-1537.
28. Hsing, Y. (2010), The Government Debt and the Long Term Interest Rate: Application of the Loanable Funds Model to Greece. *Journal of Economics Integration*, Vol. 25 No.4, pp. 722- 733.
29. Hsing, Y. (2010), The Government debt and long term interest rate: Application of an extended open-economy loanable funds model to Poland, *Managing Global transition*, Vol.8 No.3, pp. 227-237.
30. Kaiser, J. (2010), Resolving sovereign debt crisis. Towards a fair and transparent international insolvency framework, Erlassjahr.de, Freidrich Ebert Stiftung, September 2010.
31. Liew, V.K.S., (2004), What lag length selection criteria should be employ? Economic Bulletin. Acess on August 18, 2012 from http://myais.fsktm.um.edu.my/4036/1/EB-Lag_Selection_04.pdf
32. Lutkepohl, H., Saikkonnen, P. & Trenkler, C. (2001), Maximum Eigienvalue versus Trace test for the cointegrating rank of a VAR process, *The Econometrics journal*, Vol. 4, pp 287-310.
33. Mah G., Mukuddem-Petersen J., Miruka, C. & Petersen M.A. (2013a), The impact of government Expenditure on the Greece Government Debt: *An econometric analysis. Mediterranean Journal of Socail Sciences*, Vol 4 No 3, pp. 323-330.
34. Mah, G., Mukuddem-Petersenc.J., Petersen M. & Hlatshwayo L.N.P. (2013b),"Causes, consequence and cures of the Eurozone sovereign debt crisis". (Petersen M., *Economics of debt*). Nova Science Publisher, New York, pp.1-32. https://www.novapublishers.com/ catalog/product_info.php?products_id=41741.
35. Meniago C., Mukuddem-Petersen, J., Petersen M.A., & Mah G. (2013), Shocks and Household Debt in South Africa: A variance Decomposition and GIRF Analysis, *Mediterranean Journal of Social Sciences*, Vol 4 No.3, pp.379-388.
36. Mavrogordatos, G. T. & Marantzidis, N., (2010), Greece, *European Journal of Political Research*, Vol. 49 No. 7-8, pp. 991-1000.
37. Nellas, D & Becatoros, E. (2012). Greece votes to stay in Eurozone. Winnipeg Free Press. Retrieved June 30, 2012 from http://www.winnipegfreepress.com/ breakingnews/greece-votes-to-stay-in-eurozone-159394415.html.
38. Nelson, M.R., Belkin, P. & Mix, E. D. (2011), Greece's debt crisis: overview, policy responses and implications. Congressional Research Service. (7-5700).
39. Oh, W. & Lee, K. (2004), Causal relationship between energy consumption and GDP revisited: The case of Korea 1970-1999, *Energy Economics*, Vol. 26 No. 1 pp.51-59.
40. Pattillo C., Poirson, H. & Luca R. (2002), External debt and Growth. IMF working paper, Vol 39 No.2.
41. Pesaran, M. & Shin, J. (2001), Long run structural modelling, *University of Cambridge*, DAE working paper no. 9419.
42. Phillips, P. & Perron, P. (1988), Testing For Unit Roots In Time Series Regression, *Biometrika* Vol. 75 No. 2 pp. 335-346.
43. Rossi, V. & Aguilera, D. R., (2010), No Painless Solutions to Greece's Debt Crisis, International Economics Programme Paper IE PP 2010/03, Chatham House.
44. Sandoval, L., Beltran, E., Ulziikhutag, S. & Zorigt, T. (2011), The European sovereign debt crisis: Responses to the Financial Crisis. New Voices in Public Policy, Vol. 5, George Mason University, School of Public Policy.
45. Schclarek, A. (2004), Debt and Economic Growth in Developing Industrial Countries, mimeo.
46. Sims, C. (1980), Macroeconomics and reality, *Econometrica*, Vol. 48 No.1, pp.1-48.
47. Sinha, P., Arora V. & Bansal, V. (2011), Determinant of public debt for middle income and high income group countries using panal data regression. Munich personal RePEc Archive.Retrieved on April 27, 2012 from http://mpra.ub.uni-muenchen.de/32079/1/ MPRA_paper_3207 9.pdf.
48. Yue, Z.V. (2010), Sovereign default and debt renegotiation, *Journal of international Economics*, Vol. 80 No. 2, pp. 176-187.