LONG-TERM GOVERNMENT BOND RATES DETERMINANTS: EVIDENCE FROM THE GREEK ECONOMY

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Abstract

Government bond rates crucially affect a country's negotiations possibilities when applying for new loans form the secondary market. Greece has a recent and agonizing experience, when countries; officials, speculators, and the international press were against its debt viability. In this research we try to estimate as to how much other variables, such as inflation rates, national debt, and government deficit can interact with one another and finally affect the level of government bond rates. Greece is taken as a sole case in this matter. The VAR approach that is applied results in findings that show that Greece's bond rates affect inflation, and government debt affects bond rates.

JEL: E61, E65, F62

Keywords: Government bond rates, VAR approach, macroeconomic policy

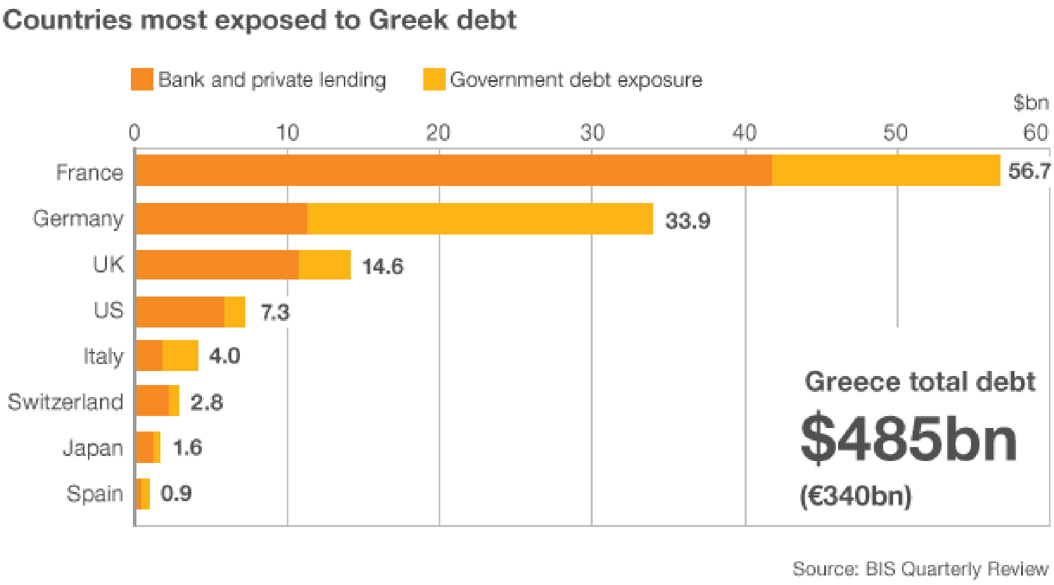
1. Introduction

The current economic crisis has affected the Greek government bond rates in many ways. This is the major test of the eurozone area. Considerable academic discussion has been peaking, shedding new light to the crisis' origins and possible solutions. During the day of writing the current research (July 2012) the 10-year Greek government bond rates were at a shocking 25.58%. The secondary bonds market seems to be rather unsatisfied and certainly not convinced by the new austerity measures taken up by the newly established government (the 'domestic troika' as it is known, due to the fact that it is comprised by three political parties).

We can briefly describe the major events of the Greek crisis that affected the Greek government bond spreads in five steps. Firstly, the spread of the 10-year Greek government bond yield ascended to 65 base points in August 2008, right after the US sub-prime crisis of 2007. Secondly, from September 2008 to March 2009, there was a peak of the global economic crisis, which interpreted into 285 b.p. for the Greek government bonds' spread. Thirdly, during the summer of 2009 a partial smoothing of the global crisis took place, and in August the Greek spread fell to 121 b.p.. Fourthly, between the end of September 2009 and in the mid-2010, Greek bond spreads rose only marginally in the range of 120-130 b.p., with the main event of the period being the new elected government. Finally, in April 2012 we saw the bonds spread moving up to 586 b.p., while similar trend were seen in Portugal and Spain.

There is a desperate need for the Greek economy to become trustworthy again and to show serious growth potentials, something that, for the time being, is not visible. Borrowing money through government bonds used to be a safe way to do so, but now it seems that bond buyers are increasingly demanding, in case they finally decide to take the risk. The following graph, Graph 1.a, depicts which countries hold the Greek debt in terms of bank and private lending and government debt exposure.

Graph 1.a: Who hold Greek bonds, i.e. who are threatened by Greek debt



The current president of the Eurogroup, Jean Claude Juncker, recently warned that the Greek debt crisis puts at least five European economies in danger. These economies are France, Germany, Great Britain, Italy, and the USA. Greek banks and insurance institutes hold about €70 billion of the Greek government's bonds. €20 billion of those bonds that are hold by banks are due in 2014, while those which are hold by the French banks are worth of €14 billion (again due in 2014). The European Central Bank (ECB) owns Greek bonds worth of €48 billion. According to the RBC Capital Markets, commercial banks control about 27% of the Greek national debt, capital managers, government investment funds and foreign banks control 43%, the ECB 14%, and the rest 16% is controlled by the European Union and the International Monetary Fund (IMF). According to Citigroup, European banks own Greek government bonds worth of €17.2 billion due in 2013, Greek banks €22 billion and the Bank of Greece €5.1 billion. The structure of the current research paper is as follows: in the 2nd part we discuss the existing literature that deals with the mechanics of public debt in terms of state bond rates. In the 3rd part we present the data and methodology adopted, while in the 4th part we present the results of the VAR estimations and comparisons with the granger causality tests. The 5th part consists of the References used the research.

2. Literature Review

Argyrou M. G and Tsoukalas J. D. (2010) presented a very interesting research paper on the causes, mechanics, and possible outcomes of the current economic crisis in general and of the Greek debt in particular. According to them, the economic crisis is the result of steadily worsening macroeconomic fundamentals over the period 2001-2009 to levels that are inconsistent with long-term EMU (European Monetary Union) participation. Adding to that, a shift in markets' expectations due to the change of (or lack of) credible commitments of the Greek government to future EMU participation seemed to have crucially affected the economic environment. Final suggestion is that the EU should establish an EU/IMF rescue mechanism in order to avoid future crises, but the final call is for the EU peripheral societies, whether they are willing to take the significant short-run welfare cost that accompanies reforms. According to the authors, it is vital for governments to communicate clearly to their citizens what are the stakes in not promoting reform now, and try to convince them that since the latter will have to take place anyway, it will be much preferable for their own long-run welfare to undertake them within the euro rather than outside it.

The sustainability of the Greek public debt is thoroughly examined by Cline R. W. (2011). The basic result is that Greece can manage is sovereign debt under the new rescue package so long as it meets the fiscal adjustment targets. A drawback of the IMF and the European Commission's methodology is that they have always focused on *gross* debt rather than on *net* debt. Furthermore, the Organisation for Economic Cooperation and Development (OECD) has reported figures for Greece that show that there are large state assets that make net debt significantly smaller than could be expected. In particular, '…the OECD estimates that at the end of 2010 gross public debt was €328 billion on the Maastricht basis; general government gross debt was € 339 billion and general government financial assets were €76 billion (OECD, 2011)'.

Mink M. and de Haan J. (2012) tried to examine any contagion effects during the Greek sovereign debt crisis that can influence bank stock prices in 2010 and other countries' government bond prices. Interestingly enough, their findings suggest that only good news about the Greek bailout project has a significant effect on bank stock prices. The markets seem to consider the fact that news about a bailout is a signal of European governments' willingness in general to use public funds to combat the economic crisis. A rather plausible explanation for the impact of news about Greece on the bond prices of other countries is that there is a 'wake-up call'. A crisis initially restricted to one country may provide new information prompting investors to reassess the vulnerability of other countries which spreads the crisis across borders.

Daniel C.B. and Shiamptanis C. (2008) investigated the way that a fiscal policy can affect the timing and the probability of the crisis. The research tried to simulate fiscal risk under two alternative fiscal responses to a crisis, and concluded that, for countries like Greece with high debt, are not to be considered safe. Since fiscal policy is not coordinated among member states of the EU, it is quite difficult to expect an overall and synchronized encounter of the financial crisis.

In 2003 Schreft S. L. and Smith B. D. tried to examine the effects of reducing government debt stock on welfare. By using a model economy with three assets, they concluded that if there is money creation, risk-taking agents, and there is a primary government budget deficit, a positive stock of government debt is optimal. Apart from that, the help of government bonds in raising welfare is thoroughly discussed. The role of risk-free government bonds creates several opinions. Some believe that they are socially beneficial, since they have a risk-free rate of return, while others argue that the same kind of benchmark can be provided by the private sector.

3. Data and Methodology

3.1 Data

The dependent variable in research is the Greek long-term government bond rates. We use this variable in the sense as the Maastricht Treaty describes it, 'as an interest rate of the cost or price of borrowing, or the gain from lending, normally expressed as an annual percentage amount. Ten year government bond yields are often used as a measure for long-term interest rates. Yields vary according to the price of the bond. Secondary market means that the bond price is not an issue price (primary market) but determined by supply and demand on the market'. We note this variable as ***IR***, while the available data from the Eurostat database is for the years 1998-2007.

In order to link possible changes in IR to other macroeconomic variables, we are using Greek national debt levels, government deficit levels and inflation levels. National debt (**variable *ND***) is defined in the Maastricht Treaty as consolidated general government gross debt at nominal value, outstanding at the end of the year. The general government sector comprises central government, state government, local government, and social security funds. The relevant definitions are provided in Council Regulation 3605/93, as amended. Data for the general government sector are consolidated between sub-sectors at the national level. The series are measured in euro and presented as a percentage of GDP. The ND data ranges from 1995 to 2011. We use the variable 'general government deficit' (***GD* variable**) in millions of euro as a percentage of GDP. More particular, it comprises of the central government's and of the social security funds. The data range is from 2002 to 2011 in yearly figures. Finally, we use inflation data (Consumer Price Index), as ***INF* variable**, ranging from 1995-2010. All data are extracted from the Eurostat database except data for inflation (denote there as 'Historical Consumers Price Indices'), which is used from the International Financial Statistics database of the IMF. As it is easily noticed, the variables' data is unbalanced, but this can be rearranged by using the appropriate command in the calculation process afterwards.

Before moving on to the methodology adopted we should address the issue of stationarity check. By conducting individual unit root tests for our variables we reached the following results (Tables 3.1.a-3.1.d):

3.1 a

Null Hypothesis: GD has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic based on SIC, MAXLAG=1)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.591365	0.4465
Test critical values:	1% level	-4.420595	
	5% level	-3.259808	
	10% level	-2.771129	

*MacKinnon (1996) one-sided p-values.

The GD variable is stationary at a 1% confidence interval.

3.1.b

Null Hypothesis: ND has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 0 (Automatic based on SIC, MAXLAG=1)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		2.280113	1.0000
Test critical values:	1% level	-4.667883	
	5% level	-3.733200	

	10% level	-3.310349	

*MacKinnon (1996) one-sided p-values.

The ND variable is stationary at a 1% confidence interval.

3.1 c
Null Hypothesis: IR has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic based on SIC, MAXLAG=1)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.550824	0.1394
Test critical values:	1% level	-4.582648	
	5% level	-3.320969	
	10% level	-2.801384	

*MacKinnon (1996) one-sided p-values.

The IR variable is stationary at a 1% confidence interval.

3.1.d
Null Hypothesis: INF has a unit root
Exogenous: None
Lag Length: 1 (Automatic based on SIC, MAXLAG=1)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.607122	0.4362
Test critical values:	1% level	-2.740613	
	5% level	-1.968430	
	10% level	-1.604392	

*MacKinnon (1996) one-sided p-values.

The INF variable is stationary at a 1% confidence interval.

Since all of our data is stationary, we can proceed to the next step of adopting our VAR model and Granger causality tests.

3.2 Methodology

We use the VAR analysis approach in order to apply the hypothesis that there are no exogenous variables that affect IR. Furthermore, we are willing to investigate whether there is any kind of granger-causality among our variables. The main implication of this theorem is that if any two variables, X_t and Y_t, are cointegrated and each one is individually integrated of order 1 (each is individually non-stationary), then either X_t must granger-cause Y_t or the opposite. In our model, we have four variables, which means that normally we will end up with a set of four different regressions. Instead of doing that, we will regress IR with each one of the rest of the variables separately to avoid any effects from the loss of degrees of freedom in our results' analysis. Therefore, our VAR regressions will be three in number, as it is explained in the Results and Discussion part.

As far as the VAR model is concerned, in the case of a two-variable model with X_t and Y_t, vector auto-regression is a set of two equations, each of which contains κ lag values of of X_t and Y_t:

$$X_t = a + \sum_{j=1}^{k} \beta_j X_{t-j} + \sum_{j=1}^{k} \gamma_j Y_{t-j} + u_t \tag{2}$$

and

$$Y_t = a' + \sum_{j=1}^{k} \beta_j Y_{t-j} + \sum_{j=1}^{k} \gamma_j X_{t-j} + u_t \tag{3}$$

where, X_t and Y_t are column vectors of observations at time t on the two variables, the u_t*'s* are the stochastic error terms (or *innovations* or *shocks*).

In our case, the three sets of vector autoregressions we examine are:

Examining the VAR relationship between:

- *Long-term government bonds interest rates and Inflation levels*

Using two lags for both variables provided us with statistically significant results:

$$IR_t = \alpha + \beta_1 INF_{t-1} + \beta_2 INF_{t-2} + \gamma_1 IR_{t-1} + \gamma_2 IR_{t-2} + u_t$$
$$INF_t = \alpha + \beta_1 IR_{t-1} + \beta_2 IR_{t-2} + \gamma_1 INF_{t-1} + \gamma_2 INF_{t-2} + u_t$$

- *Long-term government bonds interest rates and National Debt levels*

Using two lags for both these variables as well provided us with statistically significant results:

$$IR_t = \alpha + \beta_1 IR_{t-1} + \beta_2 IR_{t-2} + \gamma_1 ND_{t-1} + \gamma_2 ND_{t-2} + u_t$$
$$ND_t = \alpha + \beta_1 ND_{t-1} + \beta_2 ND_{t-2} + \gamma_1 IR_{t-1} + \gamma_2 IR_{t-2} + u_t$$

- *Long-term government bonds interest rates and Government deficit*

Using two lags for both variables provided us with not statistically significant results; therefore, we use only one lag for each variable:

$$IR_t = \alpha + \beta GD_{t-1} + \gamma IR_{t-1} + u_t$$
$$GD_t = \alpha + \beta GD_{t-1} + \gamma IR_{t-1} + u_t$$

4. Results and Discussion

Table 4.a: VAR estimates of IR and INF

Vector Autoregression Estimates
Sample (adjusted): 2000 2007
Included observations: 8 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	IR	INF
IR(-1)	0.340991	-0.318121
	(0.41692)	(0.94117)
	[0.81788]	[-0.33800]
IR(-2)	0.340782	-0.077182
	(0.28723)	(0.64840)
	[1.18646]	[-0.11903]
INF(-1)	0.211250	0.091923
	(0.34420)	(0.77700)
	[0.61375]	[0.11831]
INF(-2)	0.184513	0.279749
	(0.26135)	(0.58997)
	[0.70601]	[0.47417]
C	0.125489	3.859179
	(1.98457)	(4.48004)
	[0.06323]	[0.86142]
R-squared	0.878240	0.385264
Adj. R-squared	0.715892	-0.434383
Sum sq. resids	0.566813	2.888493
S.E. equation	0.434670	0.981240
F-statistic	5.409639	0.470036
Log likelihood	-0.762837	-7.276682
Akaike AIC	1.440709	3.069170
Schwarz SC	1.490360	3.118821
Mean dependent	4.622500	2.819880
S.D. dependent	0.815488	0.819299
Determinant resid covariance (dof adj.)		0.172182
Determinant resid covariance		0.024213
Log likelihood		-7.819579
Akaike information criterion		4.454895
Schwarz criterion		4.554197

Representation of results:

IR = 0.3409908298*IRt-1 + 0.3407823844*IRt-2 + 0.2112500751*INFt-1 + 0.1845127804*INFt-2 + 0.1254888349

INF = - 0.3181213769*IRt-1 - 0.07718155256*IRt-2 + 0.09192305632*INFt-1 + 0.2797494359*INFt-2 + 3.859178672

We clearly see that the majority of our results are statistically significant. This means that current bond rates seem to be affected firstly by their lagged values and then by the lagged values of inflation.

Table 4.b: VAR estimates of IR and ND

Vector Autoregression Estimates
Sample (adjusted): 2000 2007
Included observations: 8 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	IR	ND
IR(-1)	-0.587123	-8.491864
	(0.28924)	(2.25520)
	[-2.02988]	[-3.76545]
IR(-2)	0.951883	5.385118
	(0.20554)	(1.60257)
	[4.63121]	[3.36031]
ND(-1)	0.136916	1.302191
	(0.03844)	(0.29968)
	[3.56219]	[4.34522]
ND(-2)	-0.046890	-0.901091
	(0.02543)	(0.19826)
	[-1.84405]	[-4.54500]
C	-6.804456	72.80493
	(3.70161)	(28.8614)
	[-1.83824]	[2.52257]
R-squared	0.971352	0.906777
Adj. R-squared	0.933154	0.782479
Sum sq. resids	0.133362	8.107514
S.E. equation	0.210842	1.643930
F-statistic	25.42951	7.295198
Log likelihood	5.024997	-11.40491
Akaike AIC	-0.006249	4.101227
Schwarz SC	0.043402	4.150878
Mean dependent	4.622500	102.2875
S.D. dependent	0.815488	3.524785
Determinant resid covariance (dof adj.)		0.058305
Determinant resid covariance		0.008199
Log likelihood		-3.488086
Akaike information criterion		3.372022
Schwarz criterion		3.471323

Representation of results:

IR = - 0.5871233779*IRt-1 + 0.9518826085*IRt-2 + 0.136915571*NDt-1 - 0.04689013574*NDt-2 - 6.804455541

ND = - 8.49186434*IRt-1 + 5.385118276*IRt-2 + 1.302190918*NDt-1 - 0.9010908721*NDt-2 + 72.80492846

The majority of our results in the equations of IR and ND are not significant. The one that can be accepted as significant is the ND (-2) value in the IR equation, which means that current bond rates seem to be affected by the 2-lagged level of national debt.

Table 4.c: VAR estimates of IR and GD

Vector Autoregression Estimates
Sample (adjusted): 2003 2007
Included observations: 5 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	IR	GD
IR(-1)	0.018971	0.275493
	(0.18665)	(1.11542)
	[0.10164]	[0.24699]
GD(-1)	0.251169	-0.287659
	(0.10026)	(0.59912)
	[2.50526]	[-0.48013]
C	5.457956	-8.929964
	(1.07404)	(6.41836)
	[5.08171]	[-1.39132]
R-squared	0.768583	0.113003
Adj. R-squared	0.537166	-0.773994
Sum sq. resids	0.082958	2.962569
S.E. equation	0.203664	1.217080
F-statistic	3.321201	0.127400
Log likelihood	3.152442	-5.786240
Akaike AIC	-0.060977	3.514496
Schwarz SC	-0.295314	3.280159
Mean dependent	4.092000	-6.100000
S.D. dependent	0.299366	0.913783
Determinant resid covariance (dof adj.)		0.020192
Determinant resid covariance		0.003231
Log likelihood		0.148257
Akaike information criterion		2.340697
Schwarz criterion		1.872023

Representation of results:

IR = 0.01897076183*IRt-1 + 0.2511690651*GDt-1 + 5.457956311

GD = 0.2754925997*IRt-1 - 0.2876590988*GDt-1 - 8.929963898

The above results denote that we can accept as statistically significant the vaules of IR(-1) of the IR function and all of the variables of the GD function. This means that, as noted previously, current bond rates are affected by their past values.

At this point we are applying to Granger causality test in order to examine the direction of causality that lagged variables can have on one another. This can bee seen from the next table, 4.d:

Table 4.d: Granger Causality Tests
Sample: 1995 2011
Lags: 1

Null Hypothesis:	Obs	F-Statistic	Probability
INF does not Granger Cause GD	**8**	**6.89144**	**0.04681**
GD does not Granger Cause INF		0.18950	0.68148
IR does not Granger Cause GD	5	0.06100	0.82796
GD does not Granger Cause IR		**6.27634**	**0.12917**
ND does not Granger Cause GD	9	0.00560	0.94278
GD does not Granger Cause ND		1.20072	0.31520
IR does not Granger Cause INF	**9**	**5.63648**	**0.05521**
INF does not Granger Cause IR		0.94449	0.36866
ND does not Granger Cause INF	15	0.19503	0.66662
INF does not Granger Cause ND		0.29728	0.59558
ND does not Granger Cause IR	9	0.00534	0.94412
IR does not Granger Cause ND		1.37082	0.28606

According to the critical values, we conclude that: past inflation levels do granger cause current government debt at a 5% level of significance; that past government debt levels do granger cause current long-term bonds' interest rates at 10% level of significance; that past long-term bonds' interest rates do granger cause current inflation levels at 5% level of significance.

Table 4. e: Comparing results

Granger causality tests	**VAR models**
IR causes INF	INF = - 0.31812*IRt-1 - 0.07718*IRt-2 + 0.09192*INFt-1 + 0.27974*INFt-2 + 3.85917
GD causes IR	IR = 0.01897*IR(-1) + 0.25116*GD(-1) + 5.4579

The first case denotes that there is a one way granger causality effect from long-term Greek bond rates to the country's inflation levels. This means that recent past values of the former seem to directly affect current values of the latter. We can see from the VAR equation that lagged government bond rate levels have a marginally negative effect on current inflation rates' levels. Especially, the one-period lagged value has a larger effect (-0.3181) than the two-period lagged value does (-0.077). Regarding inflation levels as a phenomenon that appears due to both domestic and outside effects, such as malfunctioning income policy, an unjust tax policy, and a foreign trade that is constantly on deficit, it is interesting enough the fact that a variable such as the interest level that Greece is borrowing in the long-run can affect current inflation. The positive signs in our VAR equation mean that increases in past inflation levels positively affect increases in current ones. Therefore, this strengthens the statement that inflation can sincerely influence markets, primary and secondary, in terms of anticipation for the country's future. The signals sent from current macroeconomic variables are carefully read by markets and in their own turn the reveal their anticipations by increasing or lowering lending interest rates.

The same explanation can be used in order to justify our second results, namely the fact that lagged values of government debt do seem to affect current levels of bonds' interest rates. A positive relationship is present here, meaning that an increase in the level of national debt can positively influence the future interest rates charged on Greece's borrowing. As the Greek national debt increases, negative signals are sent to the markets. The country's credibility, already diminished, is caught to the vicious circle of current expensive borrowing-covering past debt and current government deficit.

Further analysis can also be made by adopting different sets of independent variables in order to fully capture all the possible alternatives that can seriously affect bond rates. Improving the method of analyzing and predicting future bond rates can be extremely helpful for the Greek government, since the secondary market is a field where many different forces (financial institutions, central banks, countries, etc) try to gain their share in terms of short term profits and long term financial domination of countries in economic need.

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