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How Reliable are Budget Sustainability Tests? A Case Study for Greece

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Abstract

In this paper we try to answer if the empirical evidence on the Greek fiscal policy has been consistent with the government intertemporal budget constraint during two tested periods, 1833-2009 and 1960-2009. The recent Greek debt crisis provides a unique opportunity to test whether sustainability tests produce what they ought to produce: We know that the Greek debt is unsustainable, so do the sustainability tests show the same? We use several common approaches such as Johansen approach, DOLS, Engle-Granger approach, Bohn test and finally Trehan-Walsh approach. Our results are mixed and in contrast with our expectations, because the majority of the tests indicate sustainable fiscal policy in both tested periods. One reason for the non-performance of the sustainability tests may be that they do not include information provided by rating agencies (which may not always be rational). Another important limitation of the present value budget constraint is the assumption of infinite growth of the economy. Additionally, the budget deficit is one of the most important fiscal instruments, and based on previous data processes.

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Keywords: Fiscal policy sustainability; Budget deficits; Government debt; cointegration; structural breaks

JEL classifications: E62, H62, H63

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Introduction

During the last twenty years many developed countries have amounted large debts, while the ability of governments to reduce the fiscal deficits has been limited. As a result, attention from economists and policy makers concerning those debts and deficits is increasing. Theoretically, equilibrium growth paths need to be supported by adequate fiscal policy. The risk of a default on Greek sovereign debt during the last 2 years has driven the Euro into its first serious crisis and raised the issue of debt sustainability in all European countries.

There is no universally accepted definition for sustainable fiscal policy. However, economists agree that exploding public debt is not sustainable. Budget policy is constrained by the need to finance the deficit. If it were possible for a government in some way to borrow without limit and to finance the interest on debt by additional borrowing, any pattern of deficits would be sustainable. However, governments meet limits of how much they can borrow from the financial markets. A violation of intertemporal budget restriction means that the fiscal policy cannot be sustained forever, because the value of debt would explode over time at a rate faster than the growth rate of the economy in the near future.

In this paper we focus on Greece, a heavily-indebted European Monetary Union country with high debt-level that has driven the European Commission to consider special fiscal rules, different to those applying to the rest of the EMU countries. Greece is an interesting economy to study the sustainability hypothesis because the country's macroeconomic performance during the post-war period has been significantly influenced by a change in the conduct of fiscal policy. The Greek budget deficit was more than 300 billion Euros or 12.5 % of GDP in 2009 and 2010, and it is projected to be that large again in 2011. Combined with the recession worldwide, the increase of the debt increased more and is expected to be more than 160% of GDP at the end of 2012. Greek budget deficits are un-sustainable in the long-run (and short-run), since public debt cannot grow for an indefinite period faster than the national output (especially during the recession). During the last 5 years a larger share of Greek national income (or external borrowing) was allocated in order to service the debt created 25-30 years ago. Since Greece is part of the EMU it is unable to create money, is very likely to default in the near future.

As we mentioned, the Greek economy faces many problems. The most important is that seeking ways to achieve sustainable and balanced growth. The latest developments in Greece have established that the growth path in Greece after the entry into the European Monetary Union (EMU) was not sustainable and has led to the sovereign debt crisis in 2009. According to the Hellenic National Reform Program 2011-2014 "It has now been made apparent that the fast growth of the recent past was based on unsustainable drivers. Upon entering the euro area, access to low-cost credit boosted demand. However, complementary changes on the supply side of the economy, which are essential in an environment of effectively fixed exchange rates, were not similarly introduced. Instead, persistent expansionary fiscal policies exaggerated the problem". (Hellenic Republic, 2011, pp. 2)

In this debate, which is currently in progress, emphasis seems to shift from the level of government deficits to the level of public debt, particularly in relation to heavily indebted countries like Greece and Portugal. Collignon (2010) stated that there is still a lively debate about the usefulness of Europe's fiscal rules set out in the Maastricht treaty. These rules have been criticized for being too tight and creating a pro-cyclical and low-growth bias for fiscal policy. They were also attacked for being too loose because they did not prevent countries like Greece and Portugal to accumulate excessive deficits. Both criticisms may lead to the conclusion that Europe's public debt is not sustainable.

During the last decade a large number of authors examined the issue of sustainability. Some studies (e.g. Quintos 1995, Wilcox 1989, Hakkio, Rush 1991, Tanner, Liu 1994, Makrydakis, Tzavalis &

Balfoussias 1999, Jayawickrama, Abeysinghe 2006) concluded that the intertemporal budget constraint is violated. However, these results may be biased since they do not take into account possible structural changes in tested variables. Another reason is that public debt and deficits present a non-linear behaviour which is not taken into account in previous studies. There are a number of studies examined individually the issue of non-linearity (e.g. Bohn 1998, Arghyrou 2004), or take into account structural changes (e.g. Quintos 1995, Makrydakis, Tzavalis & Balfoussias 1999). However, addressing only structural changes or non-linearity may lead again to incorrect results. Thus, in our examination of the sustainability of Greek fiscal policy we will take into account both factors. We include unit roots including structural breaks, the Zivot and Adrews (1992) test and the recursive Chow test (1960), and also include the Bohn test (1998) in order to allow for non-linear fiscal adjustments.

Previous work

Fiscal deficit has attracted extensive attention in public policy and in macroeconomic theory due to its impact on macroeconomic performance and the proceeding debt dynamics. According to Kustepeli and Onel (2005) budget deficit sustainability becomes an important factor that attracts the attention of economists and policy makers. Budget deficit take place when government spending exceeds government revenues and there is a need of financing them by net lending.

There are two types of analyses used to examine the sustainability of fiscal policy; time series and panel data analysis. Studies using time series analysis (e.g. Quintos 1995, Hamilton, Flavin 1986, Papadopoulos, Sidiropoulos 1999, Cipollini 2001, Qin et al. 2006) examined the long run relationship between government spending and revenues for a particular country over time. The panel data analysis (e.g. Prohl, Schneider 2006, Llorca, Redzepagic 2008, Ehrhart, Llorca 2008, Westerlund, Prohl 2010) investigated the relationship between revenues and spending across different countries at the same point in time (year). The majority of studies which used time series data have tested the sustainability for a single country, Olekalns (2000) examined the case of Australia, Hatemi-J (2002) tested the case of Sweden, while Davig (2005) examined the case of U.S.A. Only a small number of studies have examined a group of countries; Prohl and Schneider (2006) examined the EU15 countries, Westerlund and Prohl (2010) investigated the case of 8 OECD countries.

The majority of previous studies used post World-War II data and tested periods less than 50 years. However there are studies (e.g. Olekalns 2000, Bohn 2005, Trehan, Walsh 1988, Marinheiro 2006, Correia et al., 2008) which examined long data sets for single countries. Focusing on the empirical results of studies using long series, we can conclude that results are mixed and do not follow any common pattern. For instance, some of them found support of a sustainable budget deficits, Bohn (2005) found that the fiscal policy in U.S.A. was sustainable during 1792-2003, Kirchgaessner and Prohl (2006) found that Swedish deficits were sustainable during 1900-2002. On the other hand, studies such as Olekans (2000), Jha and Sharma (2004), Araoz et al. (2009) found evidence of unsustainable deficits for the cases of Australia, India and Argentina respectively. Finally, Correia et al. (2008) found that Portuguese deficits were sustainable only for some periods.

We mentioned the importance of fiscal sustainability in guaranteeing stable growth of the economy, numerous studies with different approaches have been developed to examine whether or not a country's public finances follow a sustainable path. Firstly, there are several authors that applied stanionarity tests on deficits (e.g. Trehan, Walsh 1991, Trehan, Walsh 1988), or debt (e.g. Wilcox 1989, Kremers 1988). Secondly, another strand of literature deployed cointegration tests between government spending and revenues (e.g. Hatemi-J 2002, Olekalns 2000a, Fountas, Wu 1996, Payne 1997), or cointegration tests between deficits and debt (e.g. Prohl, Schneider 2006, Bohn 2005). The idea of stationarity test (and co-integration tests) is that if the deficit is non-stationary it has an infinite variance and a non-constantmean, so that it automatically becomes uncontrollable and therefore

unsustainable. Thirdly, Markov-switching stochastic process applied by Davig (2005). Markov switching models have the advantage, that they can take a changing behaviour into account. Hence a budget deficit doesnot have to be unsustainable forever. Fourthly, Argyrou and Luintel (2007) applied Dynamic Ordinary Least Squares (DOLS).Trace test, Breitung's non-parametric test applied by Correia et al. (2008). Finally, a number of studies (Bohn 1998, Correia et al. 2008, Greiner, Koller & Semmler 2004) applied the Bohn test. The Bohn test is widely used to examine the deficit sustainability. It can be set up in a static way and in a dynamic way (Correia et al. 2008). The rationale behind the Bohn test is to check whether and to what extent the budget deficit is driven by the debt. Test results usually vary depending on whether the test is set up dynamically or not.

Greek fiscal policy attracted the interest of various scholars, the majority of their studies applied time series analysis (e.g. Papadopoulos, Sidiropoulos 1999, Fountas, Wu 1996, Arghyrou, Luintel 2007) in order to examine the relationship between government spending and expenditures, or between deficits and debt in the country. The empirical results of these studies are mixed, Papadopoulos and Sidiropoulos (1999), Arghyrou (2004), Argyrou and Luintel (2007) found that the Greek public deficits were sustainable. However, other authors such as Fountas and Wu (1996), Caporale (1995) and Makrydakis et al. (1999) found unsustainable Greek deficits.

A large volume of literature examined the sustainability of fiscal policy but there is no clear pattern on the empirical results. There is a group of studies that found supportive evidence of sustainable fiscal policy (e.g. 1998, Kustepeli, Onel 2005, Llorca, Redzepagic 2008, Trehan, Walsh 1991, Marinheiro 2006, Greiner, Koller & Semmler 2004, Martin 2000, Green, Holmes & Kowalski 2001, Archibald, Greenidge 2003). Another group of empirical studies found that the fiscal policy is not sustainable (e.g. Hakkio, Rush 1991, Qin et al. 2006, Bajo-Rubio, Diaz-Roldan & Esteve 2004, Aráoz et al. 2009, Fountas, Wu 1996, Baglioni, Cherubini 1993, Goyal, Khundrakpam & Ray 2004). There is another strand of the literature found mixed results in the sustainability of fiscal policy in a country or group of countries. These studies used data from different countries and found evidence indicate sustainability for some of these countries and different results for other ones (e.g. Caporale 1995, Papadopoulos, Sidiropoulos 1999, Payne 1997, Vanhorebeek, Rompuy 1995, Artis, Marcelino 1998, Afonso 2000, Feve, Henin 2000, Afonso 2005). Or they found evidence of sustainability for a country but for a specific period (e.g. Quintos 1995, Correia et al. 2008, Kremers 1988).

Data

Our empirical analysis has been carried out using annual data for Greece for two different periods: 1833-2009 and 1960-2009. We include two different periods because according to empirical results of previous studies such as Alogoskoufis (1995), Christodoulakis et al (1996), Bryant et al. (2001), the Greek deficits followed different patterns during the last 5 decades. This is the first attempt of investigating the issue of sustainability during the last 2 centuries (1833-2009).

The tested series are LG (log of real government spending), LR (log of real government revenues) and LDEBT (log of real public debt) for 1833-2009. According to Hondroyiannis and Papapetrou (1996) the total values of fiscal variables are the appropriate magnitudes since are those measures that are of main interest to administrators and politicians and are used in the political discussions.

The figures of government spending and revenues for the period 1960 – 2009 are expressed as GDP ratios for three reasons. First all administrative, public and political discussion are typically in terms of GDP ratios not only in Greece but in all European Union countries. Moreover, the Maastricht criteria for the fiscal indicators (debt and deficit) are in terms of GDP while the convergence program of the Greek Economy (1994-1999) has estimates for the main fiscal indicators as GDP ratios. Second, this transformation decreases the dependency upon nominal income dynamics. Finally, according to Correia et al. (2008), the standardization of data set (in our case government spending and revenues) using GDP as a common factor is crucial as it reveals the capacity of a country's output to sustain a potential public debt.

The data that we use in our paper is for the period 1833-2009 and has been obtained from several issues of the National Accounts of Greece published by the National Statistical Service of Greece while the overall government expenditures and the overall revenues of the general government are obtained from several issues of the "Budget Proposal" which is published from the Ministry of Finance on annual basis, and Dertilis (2005) and Kostelenos et al. (2007). For the period of 1960 to 2009, Gross Domestic Product in market prices is obtained from several issues of the National Accounts of Greece published by the National Statistical Service of Greece while the overall government expenditures and the overall revenues of the general government are obtained from several issues of the "Budget Proposal" which is published from the Ministry of Finance on annual basis.

The following graph shows the real government spending and revenues for the period 1833-2009 and the ratios of total government revenues and total government expenditures to GDP for the period of 1960-2009. During the second period under consideration the revenues path always lies below the public expenditure. Both series are shown to grow practically together until 1973, when the expenditure ratio shifted up to a higher level, the margin between them again widened in 1981, implying an exceedingly higher budget deficit as ratio of GDP . This gap between spending and revenues of total government further increased in 1989, as revenues sharply decreased. The same happened after 2000 as revenues sharply decreased again and spending enormously increased.

Figure 1: Government spending and Revenues (in logs) during 1960-2009

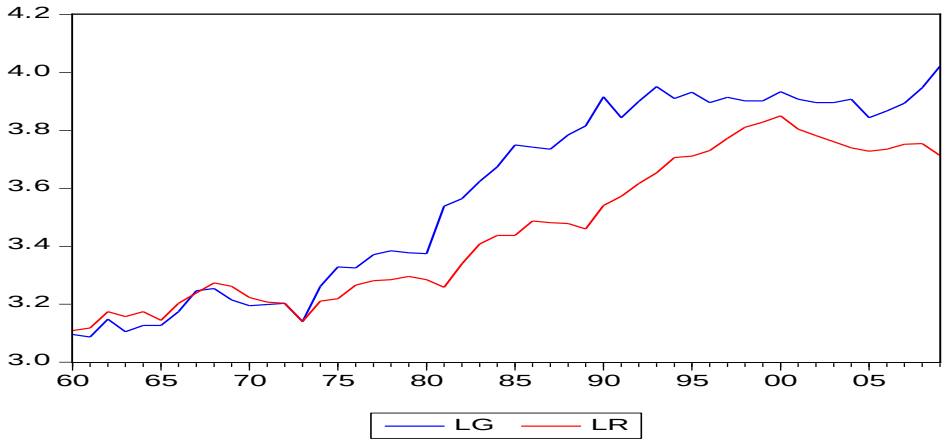
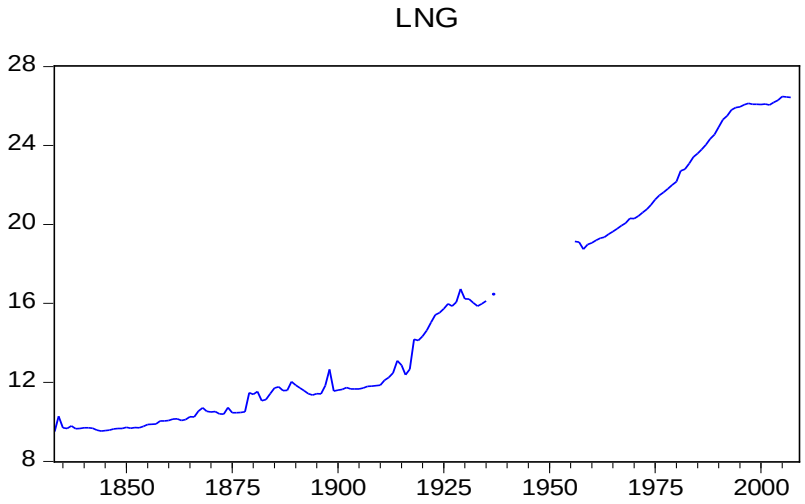
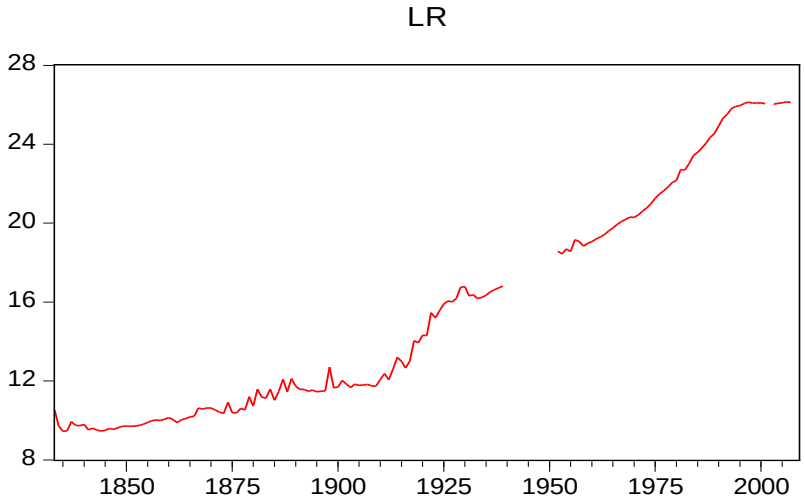


Figure 2: Government spending and Revenues (in logs) during 1833-2009





Empirical Results

Unit root tests (ADF and PP)

Many macroeconomic time series contain unit roots (dominated by stochastic trends) (Nelson & Plosser, 1982). Unit root tests examine the stationarity of time series because the presence of non-stationary regressors invalidates many standard hypotheses tests. Several tests for a presence of unit roots in time-series data have appeared in literature, some of them are Dickey and Fuller (1979), Phillips and Perron (1988) and Kwiatkowski et al. (1992). The simplest hypothesis to test whether a deficit is sustainable is to test the deficit's stationarity. If the deficit is non-stationary then it is not sustainable by definition as it would have an infinite variance and a non-constant mean.

The first step is to verify the order of integration of the variables since the causality tests are valid if the variables have the same order of integration. Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests are used in order to determine the order of integration of the tested variables and are reported in Tables 1 and 2. Our empirical results indicate that all the series (LG, LR, LDEBT) for both periods (1833-2009, 1960-2009) are non-stationary at level and stationary at first difference, so we conclude that the variables are I (1) series.

Table 1: ADF Unit Root Test, Sustainability (intercept)

1960-2009						
Variables	**ADF**	**P-value**	**Variables**	**ADF**	**P-value**	**Critical value (5%)**
LG(0)**	-0,71	0,8322	**ΔLG(0)**	-7,39*	0	-2,92
LR(0)	-0,95	0,761	**ΔLR(0)**	-5,78*	0	-2,92
LDEBT(0)	-0,75	0,8211	**ΔLDEBT(2)**	-2,98*	0,07	-2,92
1833-2009						
Variables	**ADF**	**P-value**	**Variables**	**ADF**	**P-value**	**Critical value (5%)**
LG(0)	1,73	0,99	**ΔLG(0)**	-12,5*	0	-2,88
LR (1)	2,48	1	**ΔLR (0)**	-16,9*	0	-2,87
LDEBT(3)	1,49	0,99	**ΔLDEBT(2)**	-11,15*	0	-2,88

Intercept and trend

1960-2009						
Variables	**ADF**	**P-value**	**Variables**	**ADF**	**P-value**	**Critical value (5%)**
LG(0)	-1.49	0.81	**ΔLG(0)**	-7.34*	0	-3.50
LR(8)	-2.07	0.13	**ΔLR(0)**	-5.77*	0	-3.52
LDEBT(0)	-1.00	0.93	**ΔLDEBT(0)**	-6.91*	0	-3.52
1833-2009						
Variables	**ADF**	**P-value**	**Variables**	**ADF**	**P-value**	**Critical value (5%)**
LG (0)	-1.56	0.80	**ΔLG (0)**	-13.49*	0	-3.43
LR (1)	-1.87	0.66	**ΔLR (0)**	-17.72*	0	-3.43
LDEBT (3)	-0.04	0.99	**ΔLDEBT(2)**	-7.70*	0	-3.43

Table 2: PP Unit Root Test, Sustainability (Intercept)

1960-2009						
Variables	**P-Perron**	**P-value**	**Variables**	**P-Perron**	**P-value**	**Critical value (5%)**
LG(1*)**	-0,7	0,83	**LG(2)**	-7,38*	0	-2,92
LR(1)	-0,95	0,76	**LR(1)**	-5,77*	0	-2,92
LDEBT(3)	-0,75	0,82	**LDEBT(4)**	-6,86*	0	-2,94
1833-2009						
Variables	**P-Perron**	**P-value**	**Variables**	**P-Perron**	**P-value**	**Critical value (5%)**
LG(2)	1,95	0,99	**LG(5)**	-12,87*	0	-2,88
LR(4)	2,26	1	**LR(7)**	-16,27*	0	-2,88
LDEBT(5)	1,39	0,99	**LDEBT(3)**	-11,22*	0	-2,89

Intercept and trend

1960-2009						
Variables	**P-P**	**P-value**	**Variables**	**P-P**	**P-value**	**Critical value (5%)**
LG(3)	-1.55	0.79	**ΔLG(2)**	-7.33*	0	-3.50
LR(2)	-1.40	0.84	**ΔLR(1)**	-5.76*	0	-3.50
LDEBT(4)	-1.24	0.88	**ΔLDEBT(4)**	-6.86*	0	-3.53
1833-2009						
Variables	**P-P**	**P-value**	**Variables**	**P-P**	**P-value**	**Critical value (5%)**
LG(1)	-1.54	0.8	**ΔLG(3)**	-13.59*	0	-3.43
LR(4)	-2.43	0.36	**ΔLR(6)**	-17.57*	0	-3.43
LDEBT(4)	0.33	0.99	**ΔLDEBT(3)**	-11.64*	0	-3.43

Note: * indicate rejection of the null hypothesis at the 5% level of significance. .** number in parentheses of ADF indicates the lag length based on SIC.***number in parentheses in PP indicates the Bandwinth, Newey-West using Barlett kernel.

There are problems with the stationarity tests. Perron (1989) has shown that in the presence of structural breaks a time series appears to be non-stationary when in fact it is stationary. Hence, if structural breaks are not taken into account the power of the unit root test is weak. So it is no surprise that the unit root tests are skewed towards non-stationarity rather than stationarity. As a result, when applying stationarity tests, one has to be extremely careful. In our case, we can assume that there were structural breaks and we will return to this issue below. Nevertheless, as stationarity tests are so common we include the above results as a reference point.

Engle and Granger cointegration method

One simple method of cointegration is Engle-Gragner (EG) or Augmented Engle-Gragner (AEG) test (1987). This approach is based in the idea that if there is a cointegration between the variables, the residuals that will be obtained from equation (2), has to be stationary. So, in order to test for long run relationship between the variables government spending and government revenues, we are testing the stationarity of residuals with the help of ADF.

$$\boldsymbol{R_t = a + bGG_t + c\,DM + \varepsilon_t} \qquad \textbf{(2)}$$

As we mentioned before our analysis is for two different periods (1833-2009 and 1960-2009). So the equation (2) will take two different forms in order to check the stationarity of residuals for both periods. In both the new equations will be included dummy variables[3], 1980 and 1990 in the first period, 1905 and 1917 in the second one.

[3] We applied the Zivot and Adrews (1992) and the recursive Chow test (1960) in order to examine for possible structural changes in our series. We found that LG and LR for the first tested period 1833-2009 have structural changes at 1905 and 1917. Additionally, for the second period LG has structural breaks at 1974, 1980 and 1990, while the LR has breaks at 1974, 1980, 1990 and 2002.

For the first period (1833-2009) is:

$$\boldsymbol{R_t = a + bGG_t + c\,DM1905 + dDM1917 + \varepsilon_t} \quad \textbf{(3)}$$

and for the second period (1960-2009):

$$\boldsymbol{R_t = a + bGG_t + c\,DM1980 + dDM1990 + \varepsilon_t} \quad \textbf{(4)}$$

So we are testing if the residuals $\varepsilon_t = R_t - a - bGG_t - c\,DM - dDM$ have a unit root, by performing a unit root test. The results reported in Table 3 indicate that we cannot reject the null hypothesis that there is unit root at 5% significance level for the second period, while we reject the null hypothesis in the entire period (1833-2009). According to Gujarati (2003), equation (2) is a cointegrating regression and this regression is not spurious, even though individually the two variables (r and g) are non-stationary.

For the first period (1833-2009),

$$LR_t = 0.049 + 0.9975LGG_t + 0.087DM1905 + 0.31DM1917 + \varepsilon_t$$

(1.12) (36.9) (0.45) (1.75)

R-Sq: 0.99, Adj. R-Sq: 0.99, F: 45, D-Watson: 1.68, Breusch-Godfey Serial CorrelationLM test: 0.54 (F-critical: 3.04), Breusch-Pagan-Godfrey: 1.10 (F-critical: 2.65)

and for the second period (1960-2009):

$$LR_t = 1.56 + 0.51LGG_t - 0.02DM1980 + 0.193DM1990 + \varepsilon_t$$

(5.19) (5.48) (-0.6) (6.03)

R-Sq: 0.94, Adj. R-Sq: 0.94, F: 28, D-Watson: 1.92, Breusch-Godfey Serial CorrelationLM test: 3.77 (F-critical: 4.31), Breusch-Pagan-Godfrey: 2.186 (F-critical: 3.23)

Table 3: Engle and Granger Cointegration Method (Unit root tests)

1833-2009		**1960-2009**	
t-statistic	-12,45*	t-statistic	-7.24*
t-critical	-2,88	t-critical	-2,92
Conclusion	Stationary	Conclusion	Stationary

Johansen cointegration method

One alternative method of testing cointegration is the maximum likelihood approach of Johansen (1988) and Johansen and Juselius (1990), which requires that our series are stationary. We are using the methodology of VAR (vector autoregression) and we will find the maximum number of cointegration vectors between the tested variables. The first step is to define the lag order, and based on Schwarz information criterion (SC), Final prediction error (FPE), Akaike information criterion (AIC), Hannan-Quin information criterion (HQ) and LR test statistic. In the first period we find 7 lags, while in the second 1 lag. The diagnostic tests are presented in table 5 and indicate neither serial correlation nor heteroskedasticity in residuals of both tested periods.

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The results of Johansen approach are reported at table 4 [4]and indicate that in both of the tested periods there is one cointegration vector between government spending and government revenues. This happens because we reject the null hypothesis that r=0, so we have at least one cointegration vector. Moreover we calculate the b in order to check about sustainability of fiscal deficits, in the first period the b= 1.32 and for the second b= 1.29. So we conclude that according to Johansen approach there is no sustainability for both periods. So we can conlude that the budget deficit is sustainable for both sample periods.

For the first period (1833-2009) the equation is: $R_t = a + bGG_t + c\,DM1905 + dDM1917 + \varepsilon_t$ and for the second period (1960-2009): $R_t = a + bGG_t + c\,DM1980 + dDM1990 + \varepsilon_t$

Table 4: Johansen Cointegration Method, Sustainability

1833-2009									
Unrestricted Cointegration Rank Test (Trace)					**Unrestricted Cointegration Rank Test (Maximum Eigenvalue)**				
Hypothesized		**Trace**	**0.05**		**Hypothesized**		**Max-Eigen**	**0.05**	
No. of CE(s)	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****	**No. of CE(s)**	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****
r=0	0,2171	52,280*	35,010	0,000	**r=0**	0,2171	34,0240*	24,2500	0,0019
r=1	0,1119	18,260	18,390	0,052	**r=1**	0,1119	16,4960	17,1400	0,0200
r=2	0,0126	1,767	3,841	0,184	**r=2**	0,0126	1,7670	3,8400	0,1836
1960-2009									
Unrestricted Cointegration Rank Test (Trace)					**Unrestricted Cointegration Rank Test (Maximum Eigenvalue)**				
Hypothesized		**Trace**	**0.05**		**Hypothesized**		**Max-Eigen**	**0.05**	
No. of CE(s)	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****	**No. of CE(s)**	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****
r=0	0,3564	32,960*	29,790	0,021	**r=0**	0,3564	21,156*	21,131	0,050
r=1	0,208	11,810	15,494	0,166	**r=1**	0,208	11,196	14,264	0,145
r=2	0,012	0,615	3,841	0,433	**r=2**	0,012	0,615	3,841	0,433

Table 5: Diagnostic tests

	Heteroskedasticity	F-critical		Heteroskedasticity	F-critical
1833-2009	F(12,134)= 2,23	2,34	**1960-2009**	F(20,27)=1.83	1.99

[4] The first VAR include the following variables LR, LG, D1905, while the second VAR: LR, LG, D1980.

	Chi-sq(12)=24,47	26,21 (10%)		Chi-sq(20)=27.66	31.41

	Autocorrelation			Autocorrelation	
	LM-STAT	**Critical (Chi-sq)(df=9)**		**LM-STAT**	**Critical (Chi-sq)(df=9)**
1833-2009	14,36	16,91	**1960-2009**	7.63	16.91

Dynamic Ordinary Least Squares (DOLS)

DOLS with LR as dependent variable

Equation (5) can also be estimated by DOLS (Dynamic Ordinary Least Squares), which is asymptotically equivalent to Johansen's (1988) maximum-likelihood estimator and according to Stock and Watson (1993) have a superior performance in small samples like ours (in the second period).

The DOLS regression is given by the following equation:

$$\boldsymbol{LR_t = a + bLG_t + \sum_{i=-k}^{k} \gamma_i \, LG_{t-1} + u_t} \qquad \textbf{(5)}$$

Equation (3) augments the standard OLS estimator by adding a number of lead and lag differences of the regressors[5].

Table 6 shows the results of DOLS, we can obtain the calculated b indicate sustainable fiscal policy. Our results for the second period are in accordance with Koumparoulis (2010) who tested the sustainability of Greek fiscal policy and he found that after the break (1981) the fiscal deficit is sustainable in the weak version after 1981

Table 6: DOLS with LR as dependent variable

1833-2009			**1960-2009**		
Variable	**Coefficient**	**t-statistic**	**Variable**	**Coefficient**	**t-statistic**
C	0,33	3,56*	**C**	1.66	6.32*
LG	0,77	14,9*	**LG**	0.48	5.88*
d1836	0,16	0,87	**d1980**	-0.004	-0.1
d1905	0,003	0,023	**d1990**	-0.2	-4.01*
d1917	0,22	1,37	**du1980*LG**	-0.02	-1.91
du1905*LG	0,011	2,69*	**du1990*LG**	0.05	7.29*
du1917*LG	0,04	3,57*			
du1836*LG	0,005	1,06			
LG(-1)	0,151	3,04*			

[5] We have to notice that the order of difference required for each regressor in generating the lead and lag term depends on the order of integration of the corresponding regressor. For example, if a regressor is I(1) then the lead and lag terms must be differenced once (i.e., Δxt). For further details see Stock and Watson (1993).

1833-2009: R-Sq: 0.99, Adj. R-Sq:0.99, F:24, D-Watson:1.88, Breusch-Godfey Serial CorrelationLM test: 0.54 , Breusch-Pagan-Godfrey: 0.51

1960-2009: R-Sq: 0.96, Adj. R-Sq:0.95, F:22, D-Watson:1.59, Breusch-Godfey Serial CorrelationLM test: 0.87 , Breusch-Pagan-Godfrey: 2.93

DOLS with LG as dependent variable

In this section we run the regression with dependent variable the LG. The DOLS regression is given by the following equation:

$$\boldsymbol{LG_t = a + bLR_t + \sum_{i=-k}^{k} \gamma_i \, LR_{t-1} + u_t} \qquad \textbf{(6)}$$

We obtain the same results that the fiscal policy is sustainable for both tested periods[6], i.e. sustainability of the deficit, since the calculated b is positive and less than 1.

Table 7: DOLS with LG as dependent variable

1833-2009			**1960-2009**		
Variable	**Coefficient**	**t-statistic**	**Variable**	**Coefficient**	**t-statistic**
C	-0.147492	-1,59	**C**	0.910375	1,780
LR	0.872910	18,36	**LR**	0.813478	2,580
d1905	-0.128658	-0,08	**d1980**	0.024744	-3,170
d1917	-0.227469	-1,38	**d1990**	-0.011725	2,290
du1905*LR	-0.030258	-3,02	**du1980*LR**	-0.024672	1,23
du1917*LR	-0.005783	-1,27	**du1990*LR**	-0.220887	-1
LR(-1)	0.170694	3,91	**LR(-1)**	0.164400	0

1833-2009: R-Sq: 0.99, Adj. R-Sq: 0.99, F: 31, D-Watson: 1.32, Breusch-Godfey Serial CorrelationLM test: 2.32, Breusch-Pagan-Godfrey: 0.79

1960-2009: R-Sq: 0.96, Adj. R-Sq: 0.95, F: 27, D-Watson: 1.58, Breusch-Godfey Serial CorrelationLM test: 3.77, Breusch-Pagan-Godfrey: 0.39

Bohn Test

The Bohn (1998) test is essentially the following equation:

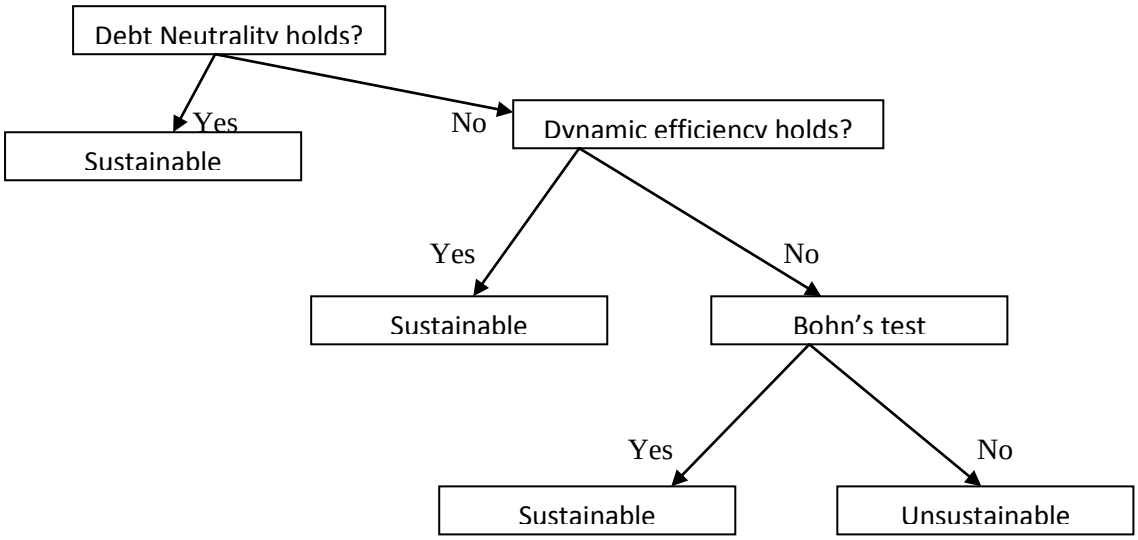
$$\boldsymbol{s_{t=}\rho_t d_t^* + \mu_t + \varepsilon_t} \qquad \textbf{(7)}$$

[6] Our results of diagnostic tests indicate neither serial correlation nor heteroskedasticity in residuals of both tested periods.

Where s_t is the primary deficit-GDP ratio, d_t^* is the debt-GDP ratio at time t (i.e. last year of debt), μ_t is the unobserved component of the model and ε_t is the residual. All the variables are time-varying. If $\rho>0$ then the deficit is sustainable.

Bohn method basically tests the relationship between public debt and primary fiscal balance. Bohn's basic idea (see figure 3) was that if government improves its primary balance when it sees an increasing public-debt-to-output ratio, then its primary balance is sustainable. He also highlighted that the positive relationship between primary balances and debts is not necessary for the sustainability of public debts when the debt-to-output ratio is low.

Figure 3: Public debt and sustainability



We employ the ordinary least square method (OLS) and obtained the value and the significance of ρ. They are reported in tables 8 and 9 and we can see that the coefficients of public debt are positive for both periods and indicate sustainability of government deficits. Secondly, we estimate recursive t-statistics for the coefficient of debt within sample development of the coefficient. In graph 4 we can see for the second period that we have sustainability of government deficits from 1960 until 1980 and from 1995 to 2007. One explanation of that will be that in 1980's the socialist party won the elections and for 18 years governed the country, they increased the government spending and public debt, increased the amount spent for pensions, increased the public sector.

Lockwood et al. (2001) stated that in Greece policymakers do not care about the public debt they are going to inherit when they come back to power. When they are near to lose the power they over-borrow, over-spend and make the public sector bigger because they know that they will not face the results and the consequences of their decisions. Moreover in Greece Socialists choose systematically a larger size of public sector than conservatives (especially in the period 1981-1991). In 1980's because the remarkable growth of Greek government sector given the need of borrowing and make the public dept higher.

Table 8: Bohn test (1960-2009)

Variable	Coefficient	t-statistic
DEBT	0.053	3.40
C	2.93	2.36

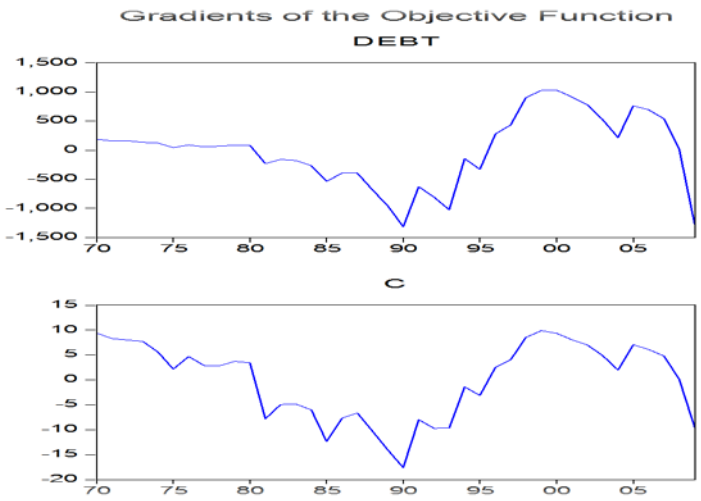
1960-2009: R-Sq:0.23, Adj. R-Sq:0.23, F:11.57, D-Watson:0.28, Breusch-Godfey Serial Correlation LM test: 0.41, Breusch-Pagan-Godfrey: 0.086

Table 9: Bohn test (1833-2009)

Variable	Coefficient	t-statistic
DEBT	2.91E-06	21.98
C	7.45E+08	1.43

1833-2009: R-Sq:0.75, Adj. R-Sq:0.75, F:48, D-Watson:0.45, Breusch-Godfey Serial CorrelationLM test: 3.77,Breusch-Pagan-Godfrey: 2.186

Figure 4: Bohn test (1960-2009)



Trehan and Walsh test

Trehan and Walsh (1991) in order to test empirically the absence of Ponzi games they propose to test the stationarity of the first difference of the stock of public debt. The sustainability hypothesis is accepted when the first difference of public debt is stationary, while the sustainability hypothesis is rejected when public debt is not stationary which can mean sustainability problems.

Afonso (2000) stated that "the stationarity of the variation of the stock of public debt is a sufficient condition, and stationarity rejection does not necessarily imply the absence of sustainability of the government accounts".(2000, pp. 14).

Table 10: Trehan and Walsh test (1960-2009)

1960-2009	Unit root test	
Variable	**t-stat ADF**	**t-critical**

ΔDEBT	-5,16	-2,94

So we can see in table 10 that the first difference of public debt is stationarity, so the fiscal policy for the tested period of 1960-2009 is sustainable. In table 11 the t-statistic of residuals of the first difference of public debt indicates that fiscal policy during this 1833-2009 is also stationary.

Table 11: Trehan and Walsh test (1833-2009)

1833-2009	**Unit root test**	
Variable	**t-stat ADF**	**t-critical**
ΔDEBT	-10.67	-2,88

Table 12: Summary of all approaches tested Sustainability

Method	**1833-2009**	**1960-2009**
Engle Gragner cointegration method	Sustainable	Sustainable
Johansen cointegration method	Not sustainable	Not sustainable
DOLS	Sustainable	Sustainable
Bohn test	Sustainable	Sustainable
Trehan walsh method	Sustainable	Sustainable

In table 12 we summarise our results from the different methods and tests that we used in order to test the sustainability of fiscal policy in Greece during the two tested periods 1833-2009 and 1960-2009. We can see that our results are mixed but the majority of them indicate sustainable fiscal policy in both tested periods (except of Johansen method). As we mentioned before the issue of sustainability of fiscal policy is dominant for the newly formed euro area. Theoretically, equilibrium growth paths need to be supported by adequate fiscal policy, however no one has proven before that Greek public debt and Greek fiscal policy is unsustainable as is expected from the current situation of Greek economy. The risk of a default on Greek sovereign debt during the last year has worried the Euro into its first serious crisis and raised the issue of debt sustainability in Europe.

One reason for the non-performance of the sustainability tests may be the unit root tests are of low power (see below). Therefore they may not be reliable. On the other hand, sustainability tests should be able to predict what happens in the future. In this sense, Greece is a good example, as Greece first of all did not default, but the financial markets lost confidence which then led to a default. The conclusion can only be that sustainability tests have to include information provided by the financial markets, for example by the rating agencies (which may not always be rational). Another important limitation of the present value budget constraint is the assumption of infinite growth of the economy. Additionally, the budget deficit is one of the most important fiscal instruments, and based on previous data processes. We have deliberately included data from different sources in order to create an as big sample as possible. Naturally that implies including structural breaks which sustainability tests have to take into account.

Additionally, according to Bohn (2007) time series related to fiscal and external deficits are frequently subjected to stationarity and cointegration tests to investigate whether the public deficits are sustainable. Such tests are incapable of rejecting sustainability. The intertemporal budget constraint appeared to be satisfied if either the debt series or the government revenue and spending series are integrated of arbitrarily high order. Bohn (2007) stated that “revenues and spending do not have to be cointegrated. Rejections of low-order difference-stationarity and of cointegration are thus consistent with the intertemporal budget constraint” (Bohn, 2007, pp. 1837).

The unit root tests are fairly standard in applied research today but their sometimes low power and size properties are also admitted. Historically, the criticisms of unit root testing have concerned both the power and size properties of conventional unit root tests (Schwert (1989), Agiakloglou and Newbold (1992), and DeJong, Nankervis, Savin, and Whiteman (1992a, 1992b). Haldrup and Jansson (2005) review some criticisms of unit root tests and the theoretical advances in increasing their power and size. Haldrup and Jansson (2005) implied that unit root tests with a null of nonstationarity may lack the power to reject a wrong null when the root of the time series is 'close to' but less than unity. In addition, misspecification regarding a trend or the numbers of lags may distort the size of the test, in which case a true null may be rejected.

Conclusion

In this paper we try to answer if the empirical evidence on the Greek fiscal policy has been consistent with the government intertemporal budget constraint during the two tested periods, 1833-2009 and 1960-2009. Especially for the first period we are testing Greek government spending and revenues using long time series data and we devoted attention to the fact that the law of motion of the time series might have changed during the sample data. We used Adrews-Zivot (1992) and a recursive Chow structural break tests in order to test for possible break points into the tested series and for the cointegrating relasionship, and we indeed found several structural breaks in both series in both tested periods.

Our attempt to assess the sustainability of fiscal policy in Greece for the two periods made through stanionarity tests (ADF and PP), we found that for both periods the tested variables (LG, LR and LDEBT) are stationary in the first difference. According to Afonso (2000) if the public debt is stationary is a sufficient condition for fiscal sustainability.

Then we tested the cointegration between government spending and revenues, the results of Johansen and Juselious approach (1990) indicates one cointegration vector in both tested periods but the calculated b indicates that the fiscal policy is not sustainable for both periods. Another cointegration technique that we used is the Engle-Gragner (1987), where the empirical results indicate sustainability of fiscal policy in both periods.

We also tested the issue of sustainability using the DOLS , which is asymptotically equivalent to Johansen's (1988) maximum-likelihood estimator and according to Stock and Watson (1993) have a superior performance in small samples like ours (in the second period). Our results indicate sustainability in both periods (before and after the structural breaks). Bohn tests also used, we found for the second period that we have sustainability of government deficits from 1960 until 1980 and from 1995 to 2009, while is sustainable for the period 1833-2009. Finally, we have tested the stationarity of the first difference of public debt and we conclude that the fiscal policy during both periods is sustainable.

These empirical results are probably in contrast with the expectations about the sustainability of Greek deficits, especially after the public debate for this topic during the last year. Greek budget deficits are now un-sustainable in the long-run, since public debt cannot grow for an indefinite period faster than the national output (especially during the recession). However, we know that Budget policy is constrained by the need to finance the deficit. If it were possible for a government in some way to borrow without limit and to finance the interest on debt by additional borrowing, any pattern of deficits would be sustainable. However, governments meet limits of how much they can borrow from the markets.

The results suggest that Greek deficits were sustainable because it was easy for the country to re-finance their needs by borrowing money by issuing bonds and selling them to private investors (domestic or overseas). An important role to the shift to unsustainable deficits was the crucial role of the rating agencies. The role of these rating agencies has become one of the most debated issues during the last 12 months, after the downgrades of some EU governments.

This means that they informed the investors that if they will invest in bonds of these countries, there is a high risk of not being paid back the full amount. Downgrading or low grading of countries means that bonds can only be issued or loans obtained, at very high interest rates and has negative impacts on the entire economy of a country and its population. The rating agencies can therefore create a downward spiral or self-fulfilling prophecy with regards of the sustainability of the public deficit. What is required is an approach that takes into account the rating of the agencies.

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