Is the Greek budget deficit sustainable after all? Empirical evidence accounting for regime shifts

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Abstract

This article re-examines the sustainability of the Greek budget deficit by using a formal framework based on the government's intertemporal budget constraint. The empirical analysis uses annual data from 1960 to 2011 and employs traditional as well as more recent unit root and cointegration techniques that account for linear and nonlinear effects in fiscal policy actions. Unlike previous studies, the evidence suggests that, allowing for structural breaks, the Greek budget deficit is unsustainable. The parameter after the second detected break reflects the structural deficiencies of the Greek economy.

JEL Classification: C22, E62, H61, H62

I. Introduction

In the recent past, many European countries have experienced several problems due to large fiscal imbalances. This fact, along with the recent global financial crisis, has further stimulated the interest over fiscal discipline within the EU. Persistent and excessive fiscal deficits have detrimental effects on debt accumulation, interest rates and economic growth, and may eventually result in insolvency, reflecting the inability of the government to stabilize its public debt ratio and repay its debts. In addition, excessive deficits may lead to the monetization of the budget deficit (for countries that are not in currency unions), and hence inflationary pressures and, secondly, they may also induce speculation and arbitrage in the financial markets, possibly rendering further government borrowing to service the debt to become infeasible. Moreover, within a monetary union, as is the European Monetary Union (EMU), large fiscal imbalances in one country can create negative externalities for the other countries, which may further jeopardize the overall credibility of the common currency. On the other hand, a balanced budget deficit secures fiscal discipline and hence monetary policy could be implemented more effectively, either on the national level or in the context of a monetary union.

The criterion that is usually employed to evaluate whether a fiscal deficit is controllable, is fiscal sustainability. According to Hamilton and Flavin (1986), who introduced the present value borrowing constraint approach, governments are subject to an intertemporal budget constraint (IBC). Accordingly, a fiscal deficit is considered sustainable only if the IBC is expected to hold in present value terms. In this context of the IBC, a large number of empirical efforts have examined the sustainability of a country's fiscal deficit (Trehan and Walsh, 1988 and 1991; Hakkio and Rush, 1991; Tanner and Liu, 1994; Liu and Tanner, 1995; Payne, 1997; Wu, 1998; Martin, 2000; Green *et al.*, 2001; Hatemi-J, 2002a, 2002b; Afonso, 2005; Kalyoncu, 2005; Bajo-Rubio *et al.*, 2008, Legrenzi και Milas, 2012, and others).

Most empirical efforts regarding the issue of fiscal sustainability, either focused on testing the discounted government debt or deficit for stationarity (Hamilton and Flavin, 1986; Makrydakis *et al.*, 1999; Ono, 2008, and others) or on the presence of a long-run relationship between government revenues and spending, adopting the cointegration framework (Hakkio and Rush, 1991; Haug, 1995; Quintos, 1995; Martin, 2000, and others). However, such time series methodologies are validated only under certain assumptions, regarding the integration properties of the involved variables and the possible presence of structural breaks. In fact, the usage of non-stationary series might lead to misspecified dynamic relationships and unreliable inference (the spurious regression problem). Furthermore, Gregory and Hansen (1996) have showed that if the presence of a structural break in the long-run relation is ignored, one might accept the null hypothesis of no cointegration between the examined variables, even though a long-run relation may actually exist. Despite the importance of taking into account structural changes, a rather small number of research efforts on fiscal sustainability has accounted for possible structural breaks (among them, Quintos, 1995; Martin, 2000; Marinheiro, 2006; Payne and Mohammadi, 2006; Baharumshah and Lau, 2007; Bajo-Rubio *et al.*, 2008; Payne *et al.*, 2008; Kia, 2008; Lusinyan and Thornton, 2009; Holmes *et al.*, 2010; Lusinyan and Thornton, 2011; Hatemi-J and Zanella, 2013).

The issue of the Greek fiscal deficit sustainability has attracted worldwide attention and interest over the recent past and especially after the outbreak of the global economic crisis which revealed the structural deficiencies of the Greek economy. Several past studies (Papadopoulos and Sidiropoulos, 1999; Katrakilidis and Tabakis, 2006; Arghyrou and Luintel, 2007) have provided evidence in favor of fiscal sustainability. In a more recent article, Richter and Paparas (2013) applied a battery of methodologies which, in most cases, indicated a sustainable Greek fiscal deficit. On the other hand, Fountas and Wu (1996) and Makrydakis *et al.* (1999) showed that accounting for structural changes, the fiscal deficit proved unsustainable.

Bearing all the above in mind, the present article contributes to the existing empirical literature by applying several traditional as well as more recent time-series methodologies to provide clear insight and robust inference regarding the key issue of Greek fiscal sustainability. In particular, it employs the single-equation cointegration techniques of Engle-Granger (1987) and ARDL (Pesaran and Shin, 1999; Pesaran *et al.*, 2001) as well as the more general one suggested by Johansen (1988) and Johansen and Juselius (1990) based on a VAR framework. Additionally, given the distortion of reliable inference under the presence of structural breaks, we apply the Gregory and Hansen (1996) and the Hatemi-J (2008) residual-based cointegration methodologies, which account for one and two possible breaks, respectively, endogenously determined, in both the intercept and the slope of the cointegrating relationship. More insight is further provided through the estimated long-run coefficients derived from the application of the Hatemi-J cointegration method, thus offering clearer information regarding the temporal stability of the slope coefficient and hence, identification of periods with possible changes in the long-run performance of the fiscal deficit. Unlike previous studies the presented findings provide evidence against Greece’s fiscal sustainability.

The article is structured as follows. Section II presents briefly some historical facts concerning the Greek budget deficit. Section III presents the intertemporal budget constraint framework for analyzing budget deficit sustainability. Section IV focuses upon the methodologies applied, while Section V presents the empirical results. The last Section provides a summary and conclusions.

II. A Brief Historical Reference on the Greek Budget Deficit

During the last forty years, political considerations have mainly driven Greek fiscal policy. The fiscal deficit and the public debt soared since budgets were subjected to either little or no discipline (Manessiotis and Reischauer, 2001). The evolution of the ratios of the Greek government revenues and government expenditures to GDP is presented in Fig. 1, while Fig. 2 presents the evolution of the Greek budget deficit. It is evident that since 1973 Greek government expenditures have always been higher than revenues and while the relevant gap shrunk briefly in 2000, it was widened further afterwards.

[Figs 1 and 2 here]

Important events over the first sub-period of our sample (1960-1974), include the association agreement of Greece with the European Economic Community (1961) and the military dictatorship imposed during the years 1967 to 1974. The military dictatorship implemented massive public expenditure programs for infrastructure and military modernization, which contributed to minor increases in the budget deficit but also resulted in higher growth rates. The later period, from the mid 1970’s to the first half of the 1980's, includes two important events: the second international petroleum crisis (1979) and the accession of Greece in the European Economic Community (1981). Throughout the 1980’s, subsequent fiscal expansions, contributed to a rapid rise of the Greek budget deficit from 2.36% in 1980 to 14.31% in 1990. The two devaluations of the national currency in 1983 and 1985 along with the 1985-1987 stabilization program (abandoned in late 1987), did not prove sufficient to reverse the fiscal imbalance (Manessiotis and Reischauer, 2001). The debt-to-GDP ratio from the 22% in 1980, advanced radically to 72% in 1990.

During the 1990’s, the Greek government intensified the efforts for fiscal consolidation in order to meet the criteria set by the Maastricht treaty[1] (1992) and to qualify for the EMU. Another important step towards the EMU was the introduction of the Stability and Growth

[1] The Maastricht treaty criteria required the economies of the candidate European countries to converge to low inflation rates, interest rates, stable exchange rates, a budget deficit no greater than 3% of GDP and a debt-to-GDP ratio no greater than 60% of GDP.

Pact (SGP) in 1997 to ensure lasting fiscal convergence among the candidate EMU countries. Accordingly, Greece implemented its first convergence program (1993-1998), and a revised convergence program (1994-1999), so as to meet the criteria set by the EU. Fiscal policy changed considerably as deficits were cut by more than 40%. Primary surpluses appeared since the mid-1990's, the budget deficit declined from 10.23% in 1991 to 3.70% in 2000 and the debt-to-GDP ratio started to stabilize and reduce.

The last decade (2001-2011) is probably the most interesting. The most significant event of this period was the accession of Greece to the EMU (2001), and the adoption of the new euro-currency. During 2001-2002, fiscal discipline due to the continuous need for compliance with the Maastricht treaty and the SGP, resulted in preserving the budget deficit at low levels. However, the organization of the 2004 Olympics, which resulted in huge public spending, had a negative effect on the budget deficit which reached 7.4% in 2004. As a result, the Greek economy deviated from the Maastricht Treaty fiscal criteria, and ended up under continuous supervision from the European Commission.

The country's economic performance changed dramatically near the end–of the last decade, partly due to the current global economic turmoil and mostly due to its unresolved structural economic deficiencies. In 2009, the deficit was extremely high, at the 15.7%, while, simultaneously, the public debt from 101.7% in 2002, advanced to 129.4% in 2009. The above facts resulted in the downgrading of the country's credibility by the rating agencies and, consecutively, interest rates for government borrowing sky-rocketed by the beginning of 2010. In May 2010, and in order to prevent default and/or debt crisis contagion to other EU countries, IMF and EU joined forces supported the Greek economy by providing emergency loans. In years 2010 and 2011 the budget deficit was reduced to 10.3% and to 9.5%, respectively, with a socially painful austerity program. However, the public debt increased further to 145.0% in 2010 and to 165.3% in 2011.

These latest developments suggest that after the entry into the EMU, the Greek fiscal policy was in fact ill conditioned leading to the current sovereign debt crisis. One possible explanation might be 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, Hellenic National Reform Programme 2011-2014, April 2011, p. 2).

III. Budget Deficit Sustainability

The most common definition of budget deficit sustainability is based on the concept of the government's intertemporal budget constraint (IBC). Following Hakkio and Rush (1991), we assume that the deficit is financed with government bonds. Then, in every time period the government faces the following budget constraint:

$$GG_t + (1+r_t)B_{t-1} = R_t + B_t \qquad (1)$$

where GG_t is government expenditures, excluding debt servicing costs, r_t is the (one-period) real interest rate, B_t is the stock of government debt and R_t is government revenues. This equation indicates that government's payment in terms of spending and the real interest rate, is constrained by its receipts in the form of revenues and debt default. Equation 1 is then rewritten for subsequent and infinite periods, and solved to produce the IBC:

$$B_{t-1} = \sum_{s=0}^{\infty} \frac{1}{(1+r)^{s+1}} (R_{t+s} - E_{t+s}) + \lim_{s\to\infty} \frac{B_{t+s}}{(1+r)^{s+1}} \qquad (2)$$

where $E_t = G_t + (r_t - r)B_{t-1}$, and r_t is assumed to be stationary with mean r. In order to achieve a sustainable fiscal policy, the intertemporal budget solvency requires that the Non-Ponzi Game (NPG) condition holds. This implies that the second term on the right-hand side of Equation 2 goes to zero at the limit:

$$\lim_{s\to\infty} \frac{B_{t+s}}{(1+r)^{s+1}} = 0 \qquad (3)$$

Equation 3 states that the discounted value of the stock of public debt in the limit equals zero, thus ruling out the possibility of the government to finance its deficit indefinitely by issuing new debt (McCallum, 1984; Hamilton and Flavin, 1986; Barro, 1987). The government must achieve future budget surpluses equal, in present value terms, to the current value of the stock of public debt. Simply put, as long as the stock of public debt grows at a rate that is on average less than the growth rate of the economy (proxied by the real interest rate),[2] the IBC is satisfied and the budget deficit would be sustainable. On the other hand, if

[2] As Cuddington (1997, p. 8) points out, '*the NPG condition is usually justified by arguing that lenders would presumably not be willing to allow the government to perpetually pay their entire current interest obligation merely by borrowing more*' [i.e., using Equation 1, if $\Delta B_t = r_t B_{t-1}$, hence $R_t - GG_t = 0$, instead of running primary surpluses ($R_t - GG_t > 0$)]. If lenders were willing to buy such debt when $R_{t+s} - GG_{t+s} = 0$ for all s, then Equation 1 implies that the debt would grow at a rate (g_B) equal to the interest rate ($g_B = \Delta B_t / B_{t-1} = r$, not $g_B < r$), and thus the discounted debt in Equation 3 would not converge to zero and the NPG condition would fail (Hatzinikolaou and Simos, 2013, p. 63).

the discounted value of the stock of public debt in the limit does not equal zero, the government finances its entire current interest obligation as well as old debt that matures by issuing new debt, which is termed by Hakkio and Rush (1991) as bubble-financing. Furthermore, the hypothesis of sustainability is equivalent to the NPG condition (Hamilton and Flavin, 1986, p. 811) so evidence against sustainability constitutes evidence against the NPG condition, implying that a bubble-financing policy is not feasible.

According to Hakkio and Rush (1991), it is possible to assess fiscal policy sustainability through the cointegration framework. To do so, Equation 2, after imposing Equation 3, can be rewritten as below:

$$G_t - R_t = \sum_{s=0}^{\infty} \frac{1}{(1+r)^{s-1}} (\Delta R_{t+s} - \Delta E_{t+s}) \qquad (4)$$

where $G_t = GG_t + r_t B_{t-1}$ is the public spending including interest payments on the debt and Δ denotes first differences. In Equation 4, the right-hand side variables are I(0), implying that the left-hand side must be I(0) as well. In practice, if G_t and R_t are both I(1) and cointegrated, [3] then the right-hand side of Equation 4 has to be also stationary. Accordingly, the procedure to assess fiscal sustainability simply requires the estimation of the following cointegration regression:

$$R_t = a_0 + \beta_0 G_t + \varepsilon_t \qquad (5)$$

where a_0 and β_0 are the cointegrating parameters and ε_t is the error term.

Following Quintos (1995) and Martin (2000) we can distinguish among three cases:

i) The deficit is “strongly” sustainable, if and only if the I(1) processes R_t and G_t are cointegrated with the cointegrating vector $[1,-1]$ or equivalently with $\beta_0 = 1$. “Strong” sustainability means that the IBC holds and at the same time the undiscounted debt process B_t is I(1).

ii) The deficit is “weakly” sustainable, if the I(1) processes R_t and G_t are cointegrated and $0 < \beta_0 < 1$. Hakkio and Rush (1991), demonstrate that if R_t and G_t are nonstationary variables in levels and are cointegrated, the condition $0 < \beta_0 < 1$ is a sufficient criterion

[3] From another perspective, Bohn (2007) claims that the intertemporal budget constraint imposes rather weak econometric constraints on the time series properties. In particular, the IBC may well be satisfied even if the components of the budget deficit are not cointegrated and even if neither debt, nor budget revenues or spending are difference-stationary.

for sustainability.[4] In this case, as the government spends more than it receives in revenues, the risk to default increases and is forced to offer higher interest rates in order to service its debt. Therefore, this form of sustainability is incompatible with the government's ability to market its debt in the long-run.

iii) The deficit is unsustainable if $\beta_0 \leq 0$. B_t is magnified at a rate that is equal or higher than the growth rate of the economy, and the limiting term (Equation 3) is violated.

IV. Methodology

This study tests for cointegration by applying the methodology of Gregory and Hansen (1996) which allows for one structural break in the cointegration equation. The null hypothesis of the test assumes no cointegration with alternative that of cointegration with one structural break. The break date is not assumed to be known *a priori* and is determined endogenously by the data, alleviating the "data mining" problem. Actually, Gregory and Hansen (1996) proposed three alternative testing specifications for the structural change, of which one is utilized here. The specification which has been adopted here is Equation 6, which accounts for a regime shift, meaning that both the intercept and the slope may have changed significantly between sub-periods of the examined sample period:

$$R_t = a_0 + a_1 D_{1,t} + \beta_0 G_t + \beta_1 G_t D_{1,t} + \varepsilon_t \qquad (6)$$

where R_t stands for government revenues, G_t stands for government expenditures**,** a_0 is the intercept before the shift, a_1 is the change in intercept due to the shift, β_0 represents the cointegrating slope coefficient, β_1 is the change in the slope coefficient, and $D_{1,t}$ is a dummy variable for the time of the structural break τ_1, defined as, $D_{1,t} = 0$ for $t \leq \tau_1$ and $D_{1,t} = 1$ for $t > \tau_1$.

Recently, an extension of the above test, which accounts for two possible structural breaks in both the intercept and the slope, has been proposed by Hatemi-J (2008) in the following form:

$$R_t = a_0 + a_1 D_{1,t} + a_2 D_{2,t} + \beta_0 G_t + \beta_1 G_t D_{1,t} + \beta_2 G_t D_{2,t} + \varepsilon_t \qquad (7)$$

where $D_{2,t}$ is a dummy variable indicating the time of the second structural break τ_2, defined as, $D_{2,t} = 0$ for $t \leq \tau_2$ and $D_{2,t} = 1$ for $t > \tau_2$.

[4] However, in order for the trajectory of the undiscounted debt not to diverge in an infinite horizon, it is necessary to have $\beta_0 = 1$ (Hakkio and Rush, 1991, p. 433).

In both of the above methodologies, assuming R_t and G_t are both I(1) variables, in order to test for cointegration accounting for one or two structural changes, the stationarity of the residuals ε_t is examined by means of the ADF statistic and extensions of the Z_a and the Z_t test statistics of Phillips (1987). Specifically, the null hypothesis states that the residuals have a unit root, indicating lack of cointegration, while the alternative hypothesis states that the residuals do not have a unit root and therefore suggests cointegration with one or two unknown breaks, respectively. With the break date unknown *a priori*, both tests choose the break points that give the least support for the null hypothesis of a unit root in the residuals. The smallest value of the ADF, Z_a and Z_t, denoted by ADF^*, Z_a^* and Z_t^*, respectively, constitutes the strongest evidence to reject the null hypothesis of no cointegration.

V. Empirical Results

The data employed in the empirical analysis have been collected from the database of OECD, are of annual frequency and cover the period 1960-2011.The variables examined are the Greek government revenues (R_t) and government expenditures including interest payments on the debt (G_t) both scaled with GDP. The scaling of the data set using GDP as a common divider reflects the capacity of the country's output to sustain a potential public debt (Correia *et al.*, 2008) while at the same time mitigates the heteroscedasticity problems, commonly appeared in unscaled long-run series (Bohn, 1991).[5]

In the context of the empirical analysis, alternative unit root tests are complementary used to examine the integration properties of government revenues (R_t) and government expenditures (G_t). In particular, we apply the Phillips-Perron test (1988), the DF-GLS test, developed by Elliott *et al.* (1996), and the Ng and Perron test (2001). The null hypothesis in all three tests is the presence of a unit root and the results, reported in Table 1, suggest that all variables are nonstationary in levels, but they turn stationary in first differences; thus, they can be described as integrated processes of order one, I(1).

[Table 1 here]

It is well known that failure to account for the presence of possible structural breaks may result in bias in favor of a unit root; the Perron phenomenon (Perron, 1989) or the

[5] According to McCallum (1984) and Hakkio and Rush (1991), the use of ratios is more pertinent for a growing economy. On the other hand, Cuddington (1997) claims that the conversion of the present value budget constraint and the NPG condition into ratios leaves them unaffected.

converse Perron phenomenon (Leybourne *et al.*, 1998). Accordingly, and aiming at further validating that both R_t and G_t are I(1), we additionally apply two unit root tests that allow for one break; the Zivot and Andrews test (1992) and the Lee and Strazicich LM test (2004). In the former test, the null hypothesis is that of a unit root against the alternative of a trend stationary process with one unknown break; while, the latter test allows for an unknown break under both the null and the alternative hypothesis. Furthermore, both tests are applied under two alternative model specifications, A and C. Model A allows for a change in the level of the series, while Model C allows for changes in the level and slope of the trend of the series. The results from both tests are presented in Table 2 and suggest that both examined variables are I(1) with the endogenously detected breaks identified around 1995 for revenues and 1981 for expenditures. In particular, the acceptance of the null of a unit root in the levels is confirmed from both A and C models, whereas, both variables in first differences turn to stationary processes.

[Table 2 here]

Having confirmed that both R_t and G_t are first difference stationary, we test for a possible long-run relationship between them and infer regarding the sustainability of the Greek budget deficit. To this direction, we employ five cointegration methodologies; the conventional residual-based Engle-Granger (1987), the Johansen's trace test (Johansen, 1988; Johansen and Juselius, 1990), the ARDL bounds approach of Pesaran *et al.* (2001) and two more advanced ones that account either for one regime shift (Gregory and Hansen, 1996) or for two regime shifts (Hatemi-J, 2008). The null hypothesis in all five tests is that of no cointegration.

The results from the first two cointegration tests are presented in Table 3. Both the Engle-Granger test (1987), as well as the Johansen's trace test (Johansen, 1988; Johansen and Juselius, 1990), suggest the non rejection of the null hypothesis of no cointegration between R_t and G_t.

[Table 3 here]

Additionally, we employ the ARDL approach to cointegration, which was originally introduced by Pesaran and Shin (1999) and later extended by Pesaran *et al.* (2001). The ARDL method is considered the most efficient cointegration technique in small samples (Romilly *et al.* 2001) and since our data can be considered rather limited (52 observations) we proceed with implementing the bounds testing procedure. More specifically, we estimate Equation 8 below:

$$\Delta R_t = \alpha_0 + \theta_1 R_{t-1} + \theta_2 G_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta R_{t-i} + \sum_{i=0}^{q} \beta_i \Delta G_{t-i} + \varepsilon_t \qquad (8)$$

In model 8, the null hypothesis of no cointegration states that the coefficients of the lagged level variables are jointly equal to zero ($\theta_1 = \theta_2 = 0$). As suggested by Pesaran and Shin (1999) and Pesaran *et al.* (2001) the null is tested by means of a modified *F*-test (denoted as F_{PSS}) or by means of a Wald-test (denoted as W_{PSS}) in cases that certain classical assumptions (e.g. normality, spherical disturbances) are violated. The test procedure involves two critical bounds; the upper and the lower one. If the empirical value of the F_{PSS} (W_{PSS}) statistic exceeds the upper bound there is evidence of a long-run equilibrium relationship; if it lies below the lower critical bound the null cannot be rejected; if it lies between the critical bounds the test is inconclusive. Table 4 contains the empirical values of the F_{PSS} statistics along with those of the associated with them W_{PSS} statistics. The results of the bounds testing approach are in line with the first two cointegration tests suggesting that the null hypothesis of no cointegration cannot be rejected at any reasonable level of significance. The findings from the above reported cointegration tests suggest that government revenues and expenditures are not cointegrated, revealing that the Greek budget deficit is not sustainable.

[Table 4 here]

However, as Gregory and Hansen showed (1996), ignoring the presence of a structural break in the long-run relation may lead a researcher to falsely accept the null hypothesis of no cointegration between the examined variables even though a long-run relation actually exists. In this direction, we proceed by applying the Gregory and Hansen (1996) residual-based cointegration methodology which accounts for one possible break, endogenously determined, in both the level and the slope of the cointegrating relationship. The results, reported in Table 5, indicate that the null hypothesis of no cointegration is rejected at the 5% significance level, in two of the three calculated test statistics (the ADF^* and the Z_t^*), with the break date identified in 1995.

[Table 5 here]

Although the above findings provide evidence for some type of sustainability of the Greek fiscal deficit, the current Greek economic situation, and in particular since the middle of the previous decade, questions the reliability of the previous reported empirical findings. Therefore, we proceed by applying a recent residual-based cointegration methodology, proposed by Hatemi-J (2008) that accounts for two breaks, endogenously determined, which is able to provide more clear information regarding the temporal stability of the slope coefficient. According to the results presented in Table 6, the null hypothesis of no cointegration is rejected by all three test statistics (the ADF^*, the Z_t^* and the Z_a^*), with the two identified break dates located in 1988 and 1995.

[Table 6 here]

The first break could be attributed to the financial liberalization and deregulation measures undertaken in 1987 by the Greek government, in order to improve the functioning of the financial markets (Manessiotis and Reischauer, 2001). Furthermore, the stabilization program of the socialist government which was abandoned in late 1987, combined with the relaxation of wage controls and severe inflationary pressures, might have also influenced the fiscal deficit. With respect to the second break, detected in 1995, it coincides with the first stage of the revised convergence program implemented by Greece (1994-1999), in order to satisfy the Maastricht criteria and qualify for the EMU. Besides, the hard drachma policy, adopted by the Bank of Greece in 1995, might be also responsible for the detected shift.

In Table 7, we report the estimated long-run coefficients, with the two shifts derived from the application of the Hatemi-J cointegration method. The estimate of the long-run coefficient β_0 for the period 1960-1987 is 0.386, this being significantly less than one, and indicating that Greece's budget deficit was sustainable, though only in the weak sense. After the first break and during the period 1988-1994, the long-run coefficient increases by 0.753 while, after 1995 and till the end of the examined period it rapidly decreases by 1.039. Considering all the changes of the long-run parameter and especially the last sub period's substantial decrease, we calculated the net value for the entire period equal to 0.10.[6] This could be considered as evidence of deviation from sustainability in the sense that the marketability of the debt might have been sharply reduced. In an effort to further validate this conclusion we additionally test the null hypothesis $H_0 : \beta_0 + \beta_1 + \beta_2 = 0$ in Equation 7 and then infer on sustainability. The result, presented in Table 7, indicates that the null hypothesis cannot be rejected, and therefore the Greek budget deficit is unsustainable.[7]

[Table 7 here]

As already mentioned in Section III, the hypothesis of sustainability is equivalent to the NPG condition (Hamilton and Flavin, 1986). Accordingly, the lack of evidence in favor of

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[6] This value has been calculated as follows: $\beta_0 + \beta_1 + \beta_2 = 0.386 + 0.753 - 1.039 = 0.10$ (Table 7).

[7] Hatzinikolaou and Simos (2013) using data for the US fiscal and current account deficit, employed an innovative test that requires formally that the undiscounted debt be bounded and rejected sustainability. This test is very likely to provide similar inference for the Greek fiscal deficit.

sustainability in the Greek budget deficit could be considered as evidence against the NPG condition,[8] implying that the Greek government cannot continue to finance its old debt that matures by issuing new debt or, in other words, to follow a bubble-financing policy.

VI. Conclusions

In the present article we attempted to re-evaluate empirically the issue of fiscal sustainability in Greece over the period 1960-2011. The empirical analysis employed alternative cointegration techniques to account for linear, as well as for nonlinear effects in fiscal policy actions, allowing for the possible presence of structural breaks.

In particular, in the linear testing framework, the single-equation cointegration techniques of Engle-Granger (1987) and ARDL (Pesaran and Shin, 1999; Pesaran *et al.*, 2001), as well as the ML one, suggested by Johansen (1988) and Johansen and Juselius (1990), supported lack of cointegration. In contrast, the results obtained from the application of the cointegration methodologies developed by Gregory and Hansen (1996) and Hatemi-J (2008), that allow for one and two structural breaks in the cointegration vector, respectively, revealed that a long-run relationship between government revenues and expenditures exists. The detected break date from the Gregory and Hansen test was identified in 1995, while the two break dates from the Hatemi-J test were identified in 1988 and 1995. All the detected break dates coincide with important institutional and economic policy changes, aiming at stabilizing the Greek economy and thus, fulfilling the Maastricht criteria towards EMU. Further, the estimated cointegration parameters from the Hatemi-J test revealed that the Greek fiscal deficit was weakly sustainable until 1995; thereafter, turning to unsustainability, a fact that raised severe problems in the solvency of the Greek economy, as well as in the quest for further borrowing to serve the public debt.

Summing up, our findings indicated that the Greek budget deficit was weakly sustainable until some point at the (not so far) past. Greece could re-finance its needs by issuing bonds and selling them to private investors. However, the recent global economic crisis exposed the fundamental problems and the non-sustainable trends in the Greek economy. This led to the downgrade of Greek bonds by the rating agencies and consequently to the downward spiral of the sustainability of the Greek public deficit.

Undoubtedly, in order to tackle fiscal insolvency, Greece needs to adopt clear and binding rules regarding public spending and bring about genuine fiscal reforms but at the

[8] We are grateful to an anonymous referee of the journal for raising this point.

same time serious attention has to be paid on growth by stimulating the demand and controlling negative expectations. On the other hand, it has now become even more obvious how interdependent the EU economies are and hence how difficult would be to control the excessive fiscal imbalances in a monetary union such as the Eurozone. This task requires greater economic policy coordination across the EU and most importantly, reassessment of the institutional framework for national fiscal stability in the context of a European macroprudential policy. In contrast to the Stability and Growth Pact and its reliance on deficit targets, the introduction of new mechanisms targeting the expenditure side might also help towards fiscal discipline without negatively affecting growth (Brück and Zwiener, 2006; Hauptmeier *et al.*, 2011). In this direction, recently, the commitment to achieve a sustainable level of debt has been included in the European's Union primary policy objectives through the new Fiscal Stability Treaty, of March 2012. With this new treaty the European Commission makes sure that when a country is in crisis, the blame will fall automatically on government spending – even if, as in the present case, the roots of the crisis lie in the private economy.

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Table 1. Unit root tests

	PP		DF-GLS		Ng-P	
Variables	C	C/T	C	C/T	C	C/T
R_t	-0.179 (2)	-2.099 (3)	0.807 (0)	-1.774 (0)	1.261 (0)	-5.472 (0)
G_t	-0.149 (1)	-2.878 (3)	0.873 (0)	-2.771 (0)	1.272 (0)	-11.018 (0)
ΔR_t	-6.274*** (2)	-6.245*** (2)	-6.338*** (0)	-6.348*** (0)	-24.790*** (0)	-24.785*** (0)
ΔG_t	-9.259*** (2)	-9.183*** (2)	-8.547*** (0)	-9.113*** (0)	-24.000*** (0)	-23.301** (0)

Notes: Δ is the first difference operator. PP: Phillips-Perron test. DF-GLS: Elliot-Rothenberg-Stock modified Dickey-Fuller test. Ng-P: Ng-Perron test. The optimal lag structure of the PP tests is chosen based on the Newey-West bandwidth with Bartlett weights and are displayed in parentheses. The optimal lag structure of the DF-GLS and the Ng-P tests is chosen based on the Schwarz Information Criterion and are displayed in parentheses. The respective 1% then 5% and 10% critical values for the PP test are -3.58, -2.93, -2.60 and -4.15, -3.50, -3.18 for models C and C/T, respectively. The respective 1% then 5% and 10% critical values for the DF-GLS test are -2.61, -1.94, -1.61 and -3.76, -3.18, -2.88 for models C and C/T, respectively. The respective 1% then 5% and 10% critical values for the Ng-P test (MZ_a statistic) are -13.800, -8.100, -5.700 and -23.800, -17.300, -14.200 for models C and C/T, respectively. The estimation and tests were conducted using EViews 7.1. *** and ** denote rejection of the null hypothesis of a unit root at the 1 and 5%, levels, respectively.

Table 2. Zivot-Andrews and LM unit root tests with one structural break

Variables	Model A Zivot-Andrews test statistic	T_b	LM test statistic	T_b	Model C Zivot-Andrews test statistic	T_b	LM test statistic	T_b
R_t	-4.119 (0)	1994	-2.406 (0)	1994	-4.546 (0)	1995	-2.956 (2)	1989
G_t	-4.572 (0)	1981	-3.161 (0)	1980	-4.711 (0)	1981	-3.777 (0)	1983
ΔR_t	-7.173 (0) ***	2001	-6.258 (0) ***	1998	-7.557 (0) ***	2001	-6.785 (0) ***	1998
ΔG_t	-9.544 (0) ***	1974	-9.118 (0) ***	2007	-9.512 (0) ***	1974	-8.983 (0) ***	2005

Notes: Δ is the first difference operator. T_b denotes the time of break. Model A allows for a change in the level of the series and Model C allows for changes in the level and slope of the trend of the series. The optimal lag structure of the Zivot and Andrews (1992) test is chosen based on the Schwarz Information Criterion. The optimal lag structure of the Lee and Strazicich (2004) test is chosen following a *general-to-specific* approach, as suggested by Lee and Strazicich (2004). The critical values were obtained from Zivot and Andrews (1992) and Lee and Strazicich (2004). The estimation and tests were conducted using RATS 8.0. *** denotes rejection of the null hypothesis at the 1% level.

Table 3. Engle-Granger and Johansen trace tests for cointegration

Engle-Granger cointegration test	Johansen's trace test
-1.921 (0.572)	15.562 (0.199)

Notes: The respective 1%, 5% and 10% critical values for the E-G test for cointegration are -4.12, -3.46, -3.13 and are based on MacKinnon (1991). The respective 5% and 10% critical values for the Johansen trace test are 17.86 and 15.75. Lag lengths concerning the Johansen trace test were determined to be one lag based on the Schwarz Information Criterion. *p*-values are displayed in parentheses. The estimation and tests were conducted using EViews 7.1

Table 4. Bounds testing for cointegration

Equation (8): $\Delta R_t = \alpha_0 + \theta_1 R_{t-1} + \theta_2 G_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta R_{t-i} + \sum_{i=0}^{q} \beta_i \Delta G_{t-i} + \varepsilon_t$

ARDL Model Specification: (1, 0)		95% Lower Bound	95% Upper Bound	90% Lower Bound	90% Upper Bound
F_{PSS}	2.741	5.249	6.049	4.201	4.958
W_{PSS}	5.482	10.499	12.098	8.402	9.916

Statistics and Diagnostics

R^2 = 0.973

F-stat. F(2,47)= 870.11 (0.000)

Serial Correlation: $\chi^2(1)$ = 0.886 (0.346)

Functional Form: $\chi^2(1)$ = 0.407 (0.542)

Normality: $\chi^2(1)$ = 3.128 (0.209)

Heteroscedasticity: $\chi^2(1)$ = 3.160 (0.075)

Notes: The ARDL specification was selected based on the Schwarz Information Criterion. The maximum lag was set to 2. The critical value bounds were computed by stochastic simulations using 20000 replications. *p*-values are displayed in parentheses. The estimation and tests were conducted using Microfit 5.0 (Pesaran and Pesaran, 2009).

Table 5. Gregory and Hansen cointegration test with one regime shift

Equation (6): $R_t = a_0 + a_1 D_{1,t} + \beta_0 G_t + \beta_1 G_t D_{1,t} + \varepsilon_t$

ADF^*	T_b	Z_t^*	T_b	Z_a^*	T_b
-5.086**	1995	-5.187**	1995	-37.488	1995

Notes: T_b denotes the time of break. The optimal lag length is determined based on the the Schwarz Information Criterion. The critical values were obtained from Gregory and Hansen (1996). The cointegration tests were conducted using a program code written in GAUSS that was retrieved from Bruce Hansen's webpage. ** denotes rejection of the null hypothesis of no cointegration at the 5% level.

Table 6. Hatemi-J cointegration test with two regime shifts

Equation (7): $R_t = a_0 + a_1 D_{1,t} + a_2 D_{2,t} + \beta_0 G_t + \beta_1 G_t D_{1,t} + \beta_2 G_t D_{2,t} + \varepsilon_t$

ADF^*	T_{b1}	T_{b2}	Z_t^*	T_{b1}	T_{b2}	Z_a^*	T_{b1}	T_{b2}
-7.369***	1988	1995	-7.443***	1988	1995	-54.717*	1988	1995

Notes: T_{b1} and T_{b2} denote the time of breaks. The optimal lag length is determined by the Schwarz Information Criterion. The critical values were obtained from Hatemi-J (2008). The cointegration tests were conducted using a program code written in GAUSS that was produced by Hatemi-J (2009). *** and * denote rejection of the null hypothesis of no cointegration at the 1 and 10%, levels, respectively.

Table 7. Hatemi-J cointegration test with two regime shifts - The estimated values of the parameters

Equation (7) : $R_t = a_0 + a_1 D_{1,t} + a_2 D_{2,t} + \beta_0 G_t + \beta_1 G_t D_{1,t} + \beta_2 G_t D_{2,t} + \varepsilon_t$

	a_0	a_1	a_2	β_0	β_1	β_2
Coefficient	13.839***	-30.943***	52.401***	0.386***	0.753***	-1.039***
t-statistics	22.376	-3.252	5.190	19.386	3.177	-4.259

Restriction tested, $H_0 : \beta_0 + \beta_1 + \beta_2 = 0$

$F(1,46)$ = 0.674 (0.415)

Statistics and Diagnostics

R^2 = 0.974

F-stat. F(5,46)= 348.92 (0.000)

Normality: $\chi^2(1)$ = 2.578 (0.275)

CUSUM: $t(45)$ =0.125 (0.900)

Notes: Newey-West heteroscedasticity and autocorrelation consistent SEs are used. *p*-values are displayed in parentheses. *** denotes statistical significance at the 1% level.

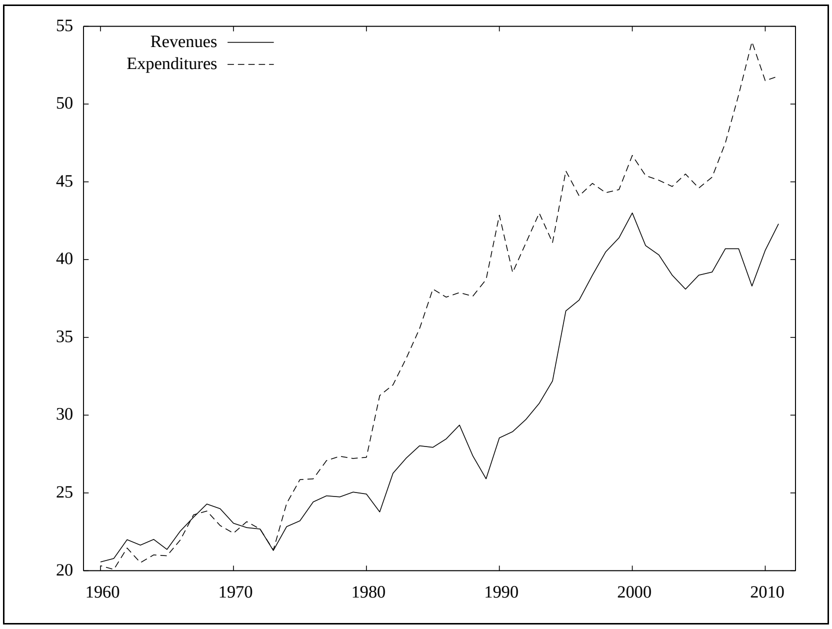

Fig. 1. The evolution of Greece's government revenues and expenditures as percentages of GDP (1960-2011)

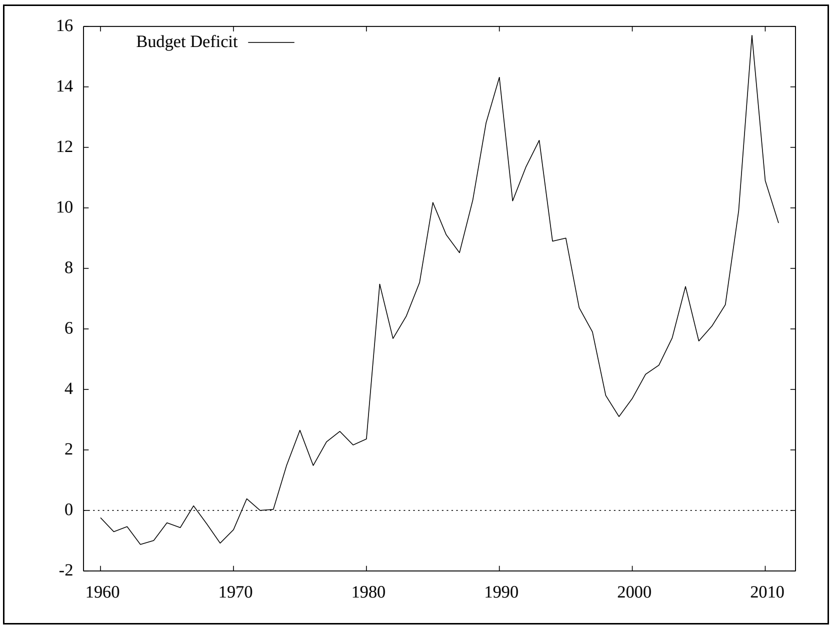

Fig. 2. The evolution of Greece's budget deficit as percentage of GDP (1960-2011)