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WORKING PAPER SERIES

Are Greek Budget Deficits 'too large'?

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Abstract

We use a residual-based cointegration test suggested by Gregory and Hansen (1992) that allows for the determination of a structural break in the cointegrating vector to test for the sustainability of Greek fiscal deficits over the 1958–1992 period. This relatively recent test leads to a different result from that derived from standard Engle-Granger cointegration tests. The use of the conventional Engle-Granger test implies no cointegration between tax revenues and interest-inclusive government expenditures. On the contrary, using the Gregory-Hansen test we conclude that tax revenues and interest-inclusive government expenditures are cointegrated and a structural break in the cointegrating vector took place in either 1981 or 1983. Our result of cointegration with a structural break is consistent with a strict interpretation of the government's intertemporal budget constraint since it implies a zero discounted value of the public debt. However, since the cointegration-regression slope parameter is significantly less than one (when tax revenues are regressed on expenditure), the undiscounted value of the public debt is different from zero. This means that the government has incentives to default on its debt and, therefore, Greek budget deficit policy is not sustainable.

1 Introduction

The existence of high and persistent fiscal deficits and the increasing debt to GDP ratio in the 1980s represent the major concern of policymakers in the Greek economy. The imbalances in the finances of the government are considered to be responsible for high interest rates and above EU-average inflation rates since the country joined the European Monetary System. The persistence of large fiscal deficits and the growing debt/GDP ratio has raised concern about the sustainability of these deficits as well as the prospects of the country to join the last stage of Economic and Monetary Union by 1999.

Recently, the development of cointegration techniques has allowed researchers to test for the sustainability of fiscal deficits. In particular. the existence of large US fiscal deficits has prompted a series of articles that test whether the US government satisfies its intertemporal budget constraint [e.g. Hakkio and Rush (1991), Haug (1991, 1995), Tanner and Liu (1994)]. The development of recent cointegration techniques that incorporate structural breaks in the tests for cointegration has allowed some authors to test for the existence of structural changes in the cointegrating vector of the involved variables that are primarily associated with election years or sharp changes in the stance of fiscal policy. In some cases. taking into account a structural break when testing for sustainability leads to a totally different conclusion. Tanner and Liu (1994) . for example. found that US fiscal deficits are sustainable when structural breaks in the cointegrating relationship are considered contrary to the result of Hakkio and Rush (1991) that was based on conventional residual-based cointegration tests.

This paper tests for the sustainability of Greek fiscal deficits using cointegration techniques that allow the statistical tests to determine the date of the structural break. The note is organized as follows: Section 2 presents a short overview of the theoretical background. Section 3 describes our econometric methodology and Section 4 our results. Finally. Section 5 summarises our conclusions.

2 Theoretical Background

Consider the government's one-period budget constraint under the assumption that government bonds have a one-year maturity:

$$G_t + (1 + i_t)B_{t-1} = T_t + B_t \tag{1}$$

where G_t is government purchases of goods and services and transfer payments. T_t is government revenue, i_t is the annual interest rate and B_t is government debt at time t.

Equation (1) holds for each period. Using the budget constraints for each period and solving equation (1) forward leads to:

$$B_0 = \sum_{t=1}^{\infty} r_t(T_t - G_t) + \lim_{n \to \infty} r_n B_n \tag{2}$$

where $r_t = \prod_{s=1}^{t} \beta_s$ and $\beta_s = 1/(1 + i_s)$

Equation (2) represents the government's intertemporal budget constraint. Solvency of the government implies that $\lim_{n \to \infty} r_n B_n = 0$, i.e., to avoid Ponzi schemes where the government issues new debt to finance its deficit, the stock of government debt B_0 must equal the present value of primary budget surpluses $\sum_{t=1}^{\infty} r_t(T_t - G_t)$.

Assuming that the interest rate i_t is stationary[1]. Hakkio and Rush (1991) transform equation (1) into an equation that has testable implications. This equation is of the form:

$$T_t = a + bGG_t + \epsilon_t \tag{3}$$

where GG_t is government spending inclusive of interest payments on the debt (Hakkio and Rush 1991, p. 432).

For budget deficits to be sustainable, T_t and GG_t must be cointegrated (i.e. ϵ_t must be stationary), provided they are non-stationary. However. $b = 1$ is not a necessary condition for the present value budget constraint to hold. As Hakkio and Rush (1991) show, the limit of the discounted value of the debt tends to zero and hence the intertemporal budget constraint holds if $0 < b \leq 1$. However. a value of b less than one makes the limit of the undiscounted value of the debt unbounded and provides incentives for the government to default on its debt. Hence, cointegration of T_t and GG_t would still imply unsustainable fiscal policy as long as $b < 1$.

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[1] Using 12-month interest rates on Treasury Bills, it turns out that the log of the nominal interest rate is stationary around a deterministic trend. ADF (1) is equal to -3.81 (the 5% critical value is -3.56).

In equation (3) above, a and b might vary over time due to structural changes in the cointegrating vector. This is more likely to happen when data cover a long-time span. In this paper, we use the Gregory-Hansen (1992) approach that tests for cointegration allowing for the statistical test to determine the date of the structural break. The use of this test represents the main innovation of our study. Our methodology is outlined in the following section.

3 Econometric Methodology

Gregory and Hansen (1992) have developed residual-based cointegration tests in models of regime shifts where the timing of the regime shift is not known *a priori* but is determined by the data. Gregory and Hansen consider four models of a regime shift depending on whether the shift affects the intercept or the slope, and whether a trend is included in the cointegrating regression. Here we consider a level shift model (model 2 in Gregory and Hansen) that takes the form

$$y_t = \mu_1 + \mu_2 \phi_t + \alpha x_t + u_t \qquad t = 1, \dots, n \qquad (4)$$

$$\text{and } \phi_t = \begin{cases} 0, & \text{if} \quad t \leq [n\tau] \\ 1, & \text{if} \quad t > [n\tau] \end{cases}$$

where $\tau \in (0,1)$ is an unknown parameter denoting the timing of the change point and [ ] denotes integer part. The use of the dummy variable ϕ_t allows one to test for a structural change or regime shift. In equation (4) above, μ_1 is the intercept before the shift and μ_2 is the change in the intercept due to the shift.

To test for cointegration between y_t and x_t with structural change, i.e., stationarity of u_t in equation (4), Gregory and Hansen (1992) suggest the use of three tests. These tests are modifications of the test statistics Z_α and Z_t (suggested by Phillips (1987)) and the ADF statistic. These statistics are defined as:

$$Z_\alpha^* = \inf_{\tau \in T} Z_\alpha(\tau)$$

$$Z_t^* = \inf_{\tau \in T} Z_t(\tau)$$

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$$\text{ADF}^* = \inf_{\tau \in T} \text{ADF}(\tau)$$

where Z_α, $Z_t(\tau)$ and $\text{ADF}(\tau)$ correspond to the choice of change point τ. The set T can be any compact subset of $(0,1)$. Gregory and Hansen (1992) suggest that a reasonable choice is $T = (0.15, 0.85)$. Following Gregory and Hansen we compute the test statistic for each break point in the interval $([0.15n], [0.85n])$. According to the definition of Z_α^*, Z_t^* and ADF^*, we are interested in the smallest values of $Z_\alpha(\tau)$, $Z_t(\tau)$ and $\text{ADF}(\tau)$ across all possible break points since small values of the statistics are required to reject the null hypothesis. Gregory and Hansen (1992) derive asymptotic critical values for alternative models. Their table 1A lists the critical values for our case (i.e. one regressor). Based on Monte Carlo evidence for the model with structural break in the intercept, they also find that Z_t^* has the largest power and Z_α^* the lowest power (see Table 5 in Gregory and Hansen (1992)).

4   Estimation and Results

We use annual data from 1958 to 1992 on total government revenue and government spending inclusive of interest payments on debt. Figure 1 plots the two series (in billions of drachmas). The data come from the International Financial Statistics of the IMF. All variables have been logged.

First, we test for stationarity of the individual time series. Table 1 includes the results of unit root tests on T_t and GG_t. According to both τ_μ and τ_τ statistics, the DF test cannot reject the null of a unit root. We use the DF instead of the ADF test since the residuals of the unit root regression are white. However, the results of Table 1 show that the first differences of the series are stationary.

Having established that tax revenue and government spending are $I(1)$, we test for cointegration between T_t and GG_t using Engle-Granger's residual-based test and assuming no structural break. According to Table 2, we cannot reject the null of no cointegration and therefore Greek fiscal deficits are not sustainable. However, this conclusion might be misleading if the long-run cointegrating relationship between T_t and GG_t has shifted over time due to a structural change.

To test for cointegration in the presence of an unknown structural break we use the three tests suggested by Gregory and Hansen (1992). Our results are given in Table 3. The break points are determined by the test and are expressed in proportion of the sample size. According to Table 3, the statistics ADF^*

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and Z_t^* indicate a structural break in years 1983 and 1981 respectively. The inability of Z_α^* to reject the null of no cointegration with structural change can be attributed to the low power of this test.

We therefore estimate the cointegrating regressions that correspond to structural breaks in 1981 and 1983. The results are given in Table 4. West-adjusted t-statistics given in parentheses [2] indicate that the intercept dummy is statistically different from zero and the cointegrating parameter (estimate of b in equation (3)) is statistically different from one. Since the estimated value of b is less than one, in accordance to our earlier discussion, the limit of the undiscounted value of the debt is infinite. This implies that the government might have incentives to default on its debt. This is especially so if revenue and government spending are measured relative to real GDP (or population).

5   Conclusions

This paper applies residual-based cointegration tests that allow for a regime shift for the insolvency of the Greek government sector. We obtain two major results: (1) The tests show that there has been a regime shift in either 1981 or 1983. These dates are consistent with the election of a Socialist government in 1981 and the accompanying large increases in government spending. Given the regime shift, government revenues and spending are cointegrated implying that the intertemporal budget constraint is, strictly speaking, satisfied. In other words, the discounted value of the debt is zero. (2) The estimated cointegrating parameter is less than one (0.963 and 0.950 when the regime shift is in 1981 and 1983 respectively). This means that government spending is growing faster than government revenue. It also means that the undiscounted value of the debt is infinite.

Based on the second result, we conclude that the Greek budget deficits are 'too large' and, therefore, the policymakers have incentives to default on their debt through debt monetization or some other means. Our result should be interpreted with caution though since we have used the Gregory-Hansen (1992) asymptotic critical values in our test of hypothesis despite our relatively small sample. To establish how big is the small-sample bias one could use a Monte Carlo study.

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[2] The West-adjusted t-statistic for b equals one instead of a standard t-statistic is used because T_t and GG_t are non-stationary. It is defined as $\tau(b,x) = (b-1)/se^*(b,x)$ where $se^*(b,x)$ is the West-adjusted standard error for b and x is the number of lags used in computing the standard error. x was set equal to 2 but our results are robust to lag lengths 4 and 6. Using this adjustment, the cointegrating parameter follows, asymptotically, a normal distribution and tests of hypotheses on this parameter can be performed. (West 1988)

Table 1: **DF Unit Root Tests**

Variable	τ_μ	τ_τ
T	3.63	-1.99
GG	3.05	-2.40
ΔT	-3.81^*	-5.22^*
$\Delta(GG)$	-3.52^*	-4.16^*

Note: τ_μ and τ_τ are the Fuller (1976) statistics for the null hypothesis of a unit root. A * indicates significance at the 5% level.

Table 2: **Engle-Granger Cointegration Tests**

	Constant	GG
	0.15	0.93
DF = -3.47		

Note: The cointegration regression is of the form $T_t = a + bGG_t + \epsilon_t$. The 5% critical value is -3.52 and is determined using McKinnon's (1991) method.

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Table 3: Gregory-Hansen Cointegration Tests with a Structural Break

	Test statistic	Break point
ADF*	$-5.34^{(a)}$	0.743
Z_t^*	$-4.58^{(b)}$	0.685
Z_α^*	-29.64	0.685

Note: ADF*, Z_t^* and Z_α^* are the test statistics defined in Section 3. The 5% critical values are -4.61, -4.61 and -40.48 respectively—see Table 1A in Gregory and Hansen (1992). (a) and (b) indicate significance at 1% and 10% respectively. The break points are given as percentages of the sample size.

Table 4: **OLS Regressions with Structural Break**

Shift: 1981	μ_1	μ_2	α
	0.038	-0.137	0.963
	(0.962)	$(-3.694)^*$	$(-3.64)^*$

Shift: 1983	μ_1	μ_2	α
	0.082	-0.088	0.950
	$(1.981)^*$	$(-2.265)^*$	$(-5.351)^*$

Note: Regressions are of the form $y_t = \mu_1 + \mu_2 o_t + \alpha x_t + u_t$, where y_t and x_t are tax revenue and government expenditure respectively. Numbers in parentheses indicate the West-adjusted t-statistics. The null hypotheses are that $\mu_2 = 0$ and $\alpha = 1$. * indicates significance at 5%.

FIGURE 1

TAX REVENUE AND GOVERNMENT EXPENDITURES: 1958 - 1992
(billions of drachmas)

6180.0

4124.9

2069.9

14.8000

1958   1967   1976   1985   1992

REV ——————   EXPE ·····················
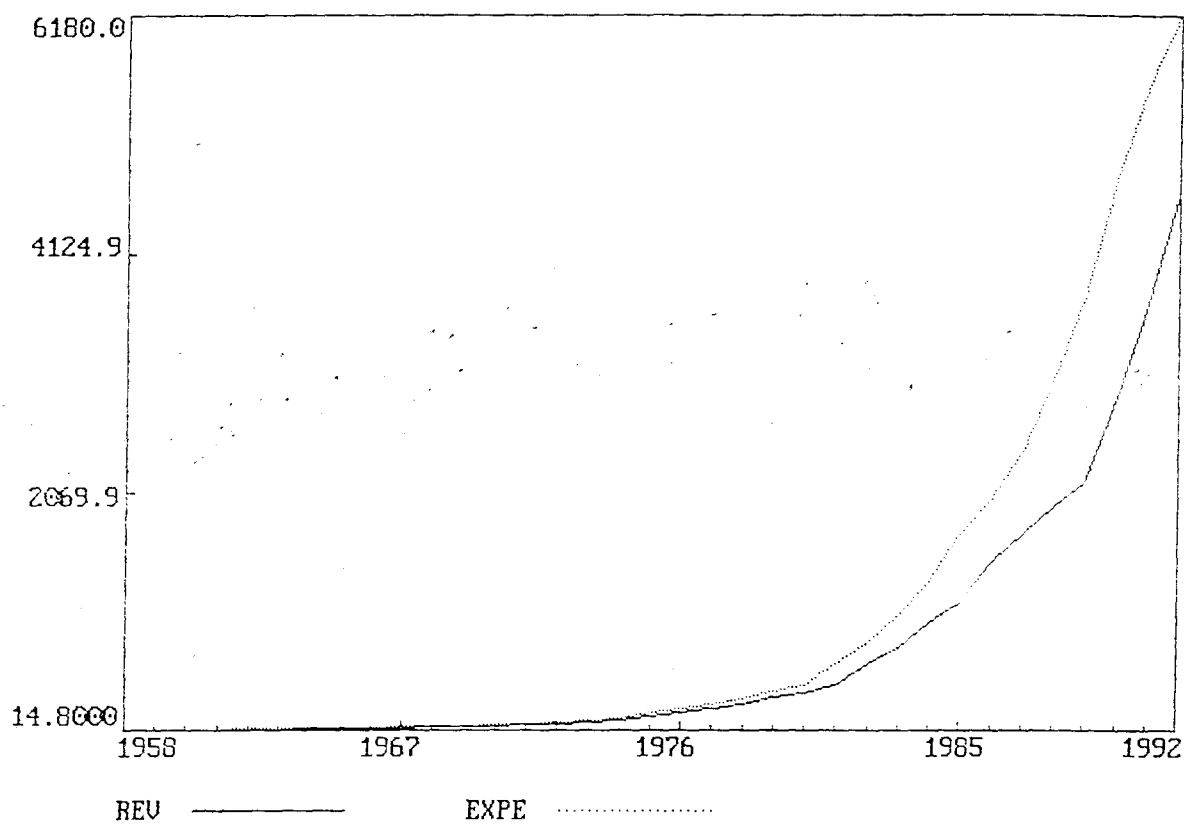
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