Fiscal Sustainability: the Unpleasant European Case*

António Afonso**

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Abstract

The sustainability of fiscal deficits has been receiving increasing attention. The issue is paramount for the newly formed euro area and this is one of the motivations of this paper. In order to assess the sustainability of budget deficits, co-integration tests between public expenditures and public revenues, allowing for structural breaks, are performed for the EU countries for the 1970-2003 period. The "unpleasant" empirical results show that with few exceptions fiscal policy may not have been sustainable. EU governments therefore could risk becoming inherently highly indebted, even if the debt-to-GDP ratios seemed to be somehow stabilising at the end of the 1990s. (JEL: H62, H63)

Keywords: Deficit finance; intertemporal budget constraint; fiscal policy sustainability; European Union

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** European Central Bank, Kaiserstraße 29, D-60311 Frankfurt am Main, Germany, email: antonio.afonso@ecb.int.
ISEG/UTL - Technical University of Lisbon, CISEP – Research Centre on the Portuguese Economy R. Miguel Lúpi 20, 1249-078 Lisbon, Portugal, email: aafonso@iseg.utl.pt.

1. Introduction

In the last two decades several developed countries have experienced significant budget deficits, while the ability of government to cope with fiscal deficits has been receiving increasing attention from economists. This is an important topic both in terms of economics and public policy. The issue is paramount for the newly formed euro area and this is one of the motivations of this paper. Theoretically, equilibrium growth paths need to be supported by adequate fiscal policy.

Furthermore, the Treaties governing the European Union impose the practical necessity of sustainable public accounts. It is possible to assess sustainable public finances in terms of compliance with the budgetary requirements of the European Monetary Union, i.e. avoiding excessive deficits, keeping debt levels below the 60 percent of GDP reference value, and respecting the "close to balance or in surplus" requirement of the Stability and Growth Pact (SGP). From a forward-looking perspective, one may also notice that the SGP imposes commitments on Member States for budgetary positions in the medium-term (three to five years) and does not require explicit longer-term targets. Therefore, sustainability is de facto ensured provided budget balances respect the "close to balance or in surplus" target.

Quite a few studies have already addressed the issue of fiscal policy sustainability and provided empirical testing of the Present Value Borrowing Constraint (PVBC)[1]. The main analytical apparatus used to analyse the sustainability of budget deficits are stationarity tests for the stock of public debt and co-integration tests between government expenditures and government revenues. This paper adds to the existing literature by applying unit root and co-integration tests to the EU-15 countries over the period 1970-2003, using consistent public finance data from one single source, the European Commission AMECO database. It also tests for the existence of structural breaks during the time sample in each country. The selected time span includes therefore the run up to

[1] Examples of such a growing literature include, for instance, Hamilton and Flavin (1986), Trehan and Walsh (1988, 1991), Kremers (1988, 1989), Wilcox (1989), Hakkio and Rush (1991), Tanner and Liu (1994), Quintos (1995), Haug (1991, 1995), Ahmed and Rogers (1995), Payne (1997), Artis and Marcelino (1998), Bohn (1998), Fève and Hénin (2000), Uctum and Wickens (2000), and Bravo and Silvestre (2002).

the introduction of the euro and the efforts, made during the 1990s, by several countries to streamline their public accounts in order to join the common currency. Additionally, both the theoretical and analytical procedures used to assess fiscal sustainability are briefly restated.

The paper is organised as follows. The next section discusses the issue of sustainability. Section three briefly reviews the analytical framework under which one usually assesses the sustainability of public deficits. Section four presents some stylised facts of fiscal policy for the EU countries. It also reports and discusses the results of the empirical analysis, comprising both stationarity tests and co-integration tests between government expenditures and government revenues for the EU-15 countries, allowing for structural breaks in the series or in the co-integration relationship. Finally, section five provides a conclusion.

2. The issue of sustainability

Fiscal sustainability seems a recurrent topic that both individual countries and international organisations dwell upon with some regularity[2]. At the beginning of the 1920s, when writing about the public debt problem faced by France, Keynes (1923, p. 24) mentioned the need for the French government to conduct a sustainable fiscal policy in order to satisfy its budget constraint. Keynes stated that the absence of sustainability would be evident when "the State's contractual liabilities (…) have reached an excessive proportion of the national income." In modern terms, sustainability is challenged when the debt-to-GDP ratio reaches an excessive value. There is a problem of sustainability when the government revenues are not enough to keep on financing the costs associated with the new issuance of public debt.

The sustainability of fiscal policy is sometimes associated with the financial solvency of the government. In practice however, what the empirical literature ends up testing is whether both public expenditures and government revenues may continue to display in the future their historical growth patterns. If a given fiscal policy turns out to be

[2] See for instance Chalk and Hemming (2000).

unsustainable, it has to change in order to guarantee that the future primary balances are consistent with the budget constraint[3]. Theoretically any value for the budget deficit would be possible if the government could raise its liabilities without limit. Obviously, that is impossible since the government is faced with the present value of its own budget constraint.

It also is worthwhile noticing that the hypothesis of fiscal policy sustainability is related to the condition that the trajectory of the main macroeconomic variables is not affected by the choice between the issuance of public debt or the increase in taxation. Under such conditions, it would therefore be irrelevant how the deficits are financed, implying also the assumption of the Ricardian Equivalence hypothesis.

The government budget constraint is the starting point to derive the present value of the budget constraint. The flow budget constraint is written as

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

where G is the government expenditures, excluding interest payments, R is the government revenues, B is the public debt and r is the real interest rate[4]. Rewriting equation (1) for the subsequent periods, and recursively solving that equation leads to the following intertemporal budget constraint:

$$B_t = \sum_{s=1}^{\infty} \frac{R_{t+s} - G_{t+s}}{\prod_{j=1}^{s} (1 + r_{t+j})} + \lim_{s \to \infty} \prod_{j=1}^{s} \frac{B_{t+s}}{(1 + r_{t+j})} . \qquad (2)$$

[3] Cuddington (1997) and Hénin (1997) discuss this topic. Blanchard et al. (1990) present as a definition of sustainable fiscal policy one that allows, in the short-term, that the debt-to-GDP ratio returns to its original level after some excessive variation.

[4] Sometimes in the literature, for the validation of theoretical results, the real interest rate is assumed stationary, but this is a much more difficult assumption for the nominal interest rate.

When the second term from the right-hand side of equation (2) is zero, the present value of the existing stock of public debt will be identical to the present value of future primary surpluses. However, equation (2) is not appropriate for empirical testing. It is therefore useful to make several algebraic modifications to equation (1). Assuming that the real interest rate is stationary, with mean *r*, and defining

$$E_t = G_t + (r_t - r)B_{t-1}, \tag{3}$$

it is possible to obtain the following so-called PVBC:

$$B_{t-1} = \sum_{s=0}^{\infty} \frac{1}{(1+r)^{s+1}} (R_{t+s} - E_{t+s}) + \lim_{s \to \infty} \frac{B_{t+s}}{(1+r)^{s+1}}. \tag{4}$$

A sustainable fiscal policy should ensure that the present value of the stock of public debt, the second term of the right hand side of (4), goes to zero in infinity, constraining the debt to grow no faster than the real interest rate. In other words, it implies imposing the absence of Ponzi games and the fulfilment of the intertemporal budget constraint. Faced with this transversality condition, the government will have to achieve future primary surpluses whose present value adds up to the current value of the stock of public debt. Put another way, public debt in real terms cannot increase indefinitely at a growth rate beyond the real interest rate[5].

It is also possible to derive the solvency condition, with all the variables defined as a percentage of GDP[6]. The PVBC, with the variables expressed as ratios of GDP, with *y* being the GDP real growth rate, and neglecting for presentation purposes seigniorage revenues, is then written as

[5] See Joines (1991). McCallum (1984) discusses if this is a necessary condition to obtain an optimal growth trajectory for the stock of public debt.

[6] For instance Hakkio and Rush (1991, p. 430) support that an analysis based on ratios is more appropriated for growing economies: "in addition to examining revenue and spending directly, we also use [to] normalize these variables using real GNP and population. This is an important extension beyond previous work since McCallum [1984], among others, deems these ratios - per capita spending and revenue, and spending and revenue as a fraction of GNP - as more pertinent for a growing economy."

$$\frac{B_t}{Y_t} = \frac{(1+r_t)}{(1+y_t)}\frac{B_{t-1}}{Y_{t-1}} + \frac{G_t}{Y_t} - \frac{R_t}{Y_t}. \qquad (5)$$

Assuming the real interest rate to be stationary, with mean r, and considering also constant real growth, the budget constraint is then given by

$$b_{t-1} = \sum_{s=0}^{\infty}\left(\frac{1+y}{1+r}\right)^{(s+1)}\left[\rho_{t+s} - e_{t+s}\right] + \lim_{s\to\infty} b_{t+s}\left(\frac{1+y}{1+r}\right)^{(s+1)}, \qquad (6)$$

with $b_t = B_t/Y_t$, $e_t = E_t/Y_t$ and $\rho_t = R_t/Y_t$. When $r > y$, it is necessary to introduce a solvency condition, given by $\lim_{s\to\infty} b_{t+s}\left(\frac{1+y}{1+r}\right)^{(s+1)} = 0$, in order to bound public debt growth[7]. This yields the familiar result that fiscal policy will be sustainable if the present value of the future stream of primary surpluses, as a percentage of GDP, matches the "inherited" stock of government debt[8].

3. Assessment of the sustainability of public deficits

A common practice in the literature, among the set of methods to evaluate fiscal policy sustainability, is to investigate past fiscal data to see if government debt follows a stationary process or to establish if there is co-integration between government revenues and government expenditures[9].

Recalling the PVBC, equation (4), it is possible to present analytically two complementary definitions of sustainability that set the background for empirical testing:

i) The value of public current debt must be equal to the sum of future primary surpluses:

[7] This implies that the growth rate of the debt-to-GDP ratio should be less than the factor $\left((1+y)/(1+r)\right)^{(s+1)}$.

[8] According to Buiter (2002), the intertemporal government budget constraint should be satisfied always and not only in equilibrium. This is Buiter's main criticism of the fiscal theory of price level.

[9] Hamilton and Flavin (1986) first used these procedures. See also Trehan and Walsh (1991) and Hakkio and Rush (1991).

$$B_{t-1} = \sum_{s=0}^{\infty} \frac{1}{(1+r)^{s+1}} (R_{t+s} - E_{t+s}) ; \qquad (7)$$

ii) The present value of public debt must approach zero in infinity:

$$\lim_{s \to \infty} \frac{B_{t+s}}{(1+r)^{s+1}} = 0 . \qquad (8)$$

In order to test empirically the absence of Ponzi games, one can test the stationarity of the first difference of the stock of public debt, using unit root tests developed by Dickey and Fuller (1981) and by Phillips and Perron (1988).

It is also possible to assess fiscal policy sustainability through co-integration tests. The implicit hypothesis concerning the real interest rate, with mean *r*, is also stationarity. Using again the auxiliary variable $E_t = G_t + (r_t - r)B_{t-1}$, and the additional definition $GG_t = G_t + r_t B_{t-1}$, the intertemporal budget constraint may also be written as

$$GG_t - R_t = \sum_{s=0}^{\infty} \frac{1}{(1+r)^{s-1}} (\Delta R_{t+s} - \Delta E_{t+s}) + \lim_{s \to \infty} \frac{B_{t+s}}{(1+r)^{s+1}} , \qquad (9)$$

and with the no-Ponzi game condition, GG_t and R_t must be co-integrated variables of order one for their first differences to be stationary.

Assuming that *R* and *E* are non-stationary variables, and that the first differences are stationary variables, this implies that the series *R* and *E* in levels are I (1). Then, for equation (9) to hold, its left-hand side will also have to be also stationary. If it is possible to conclude that *GG* and *R* are integrated of order 1, these two variables should be co-integrated with co-integration vector (1, -1), for the left-hand side of equation (9) to be stationary.

Therefore the procedure to assess the sustainability of the intertemporal government budget constraint involves testing the following co-integration regression: $R_t = a + bGG_t + u_t$. If the null of no co-integration, the hypothesis that the two I (1) variables are not co-integrated, is rejected (with a high-test statistic), this implies that one should accept the alternative hypothesis of co-integration. For that result to hold true, the series of the residual u_t must be stationary, and should not display a unit root. Several conclusions concerning the intertemporal budget constraint may then be established:

i) When there is no co-integration, the fiscal deficit is not sustainable,
ii) When there is co-integration with $b=1$, the deficit is sustainable,
iii) When there is co-integration, with $b < 1$, government expenditures grow faster than government revenues, and the deficit may not be sustainable[10].

Hakkio and Rush (1991) also demonstrate that if *GG* and *R* are non-stationary variables in levels, the condition $0 < b < 1$ is a sufficient condition for the budget constraint to be obeyed. However, when revenues and expenditures are expressed as a percentage of GDP or in per capita terms, it is necessary to have $b = 1$ in order for the trajectory of the debt to GDP not to diverge in an infinite horizon[11]. The procedure to test the sustainability of fiscal policy may be summarised, in a graphical sequential overview, by Figure 1.

[Insert Figure 1 about here]

Before proceeding it seems adequate to close the present section by summarising the empirical findings of several previous studies, concerning the issue of sustainability. Therefore, Table 1 reviews the conclusions of those papers, which cover basically the US and European countries, with sometimes quite conflicting results.

[10] Concerning this co-integration analysis approach Bohn (1991, 1995) argues that a sustainable fiscal policy in a certain environment may become unsustainable under uncertainty.

[11] Quintos (1995), Ahmed and Rogers (1995) and Bergman (2001) discuss the necessary conditions for sustainability in terms of the order of integration of public debt.

[Insert Table 1 about here]

4. Fiscal policy sustainability in the EU-15 area

This section includes some stylised facts on fiscal policy during the 1970-2003 period for the EU-15 countries. It also reports the unit root tests and estimation results of co-integrating relations between expenditures and revenues.

4.1. Some stylised facts

A brief characterisation of the debt and fiscal burden for the EU countries is appropriate before performing the empirical testing of the sustainability hypothesis. Between the beginning of the 1970s and the end of the 1990s the debt-to-GDP ratio exhibited an increasing trend for most countries throughout the period. For instance, general government debt increased in Italy from 37.9 percent of GDP in 1970, to 110.6 percent of GDP in 2000. In Germany the debt-to-GDP ratio was 18.2 percent in 1970 and went beyond the 60 per cent level in 1997. According to European Commission data, in 2003 three countries still had a debt-to-GDP ratio above 100 percent (Italy, Belgium and Greece), while in three other countries the debt ratio was higher than 60 percent (Austria, Germany and France).

In the period 1970-2003 the highest debt-to-GDP ratios were reported in Italy and Belgium (the country with the highest debt-to-GDP ratio in that period; reaching 138.2 percent in 1993), and their high debt service payments induced substantial budget deficits despite primary budget surpluses. A reversal of that general trend is noticeable only at the end of the 1990s, as the several "more indebted" countries tried to fulfil or at least come closer to the Maastricht debt criterion.

The consequences of choosing different fiscal policies may be exemplified by looking for instance at the public debt paths of some of the EU countries, as depicted in Figure 2. For instance, the adding up of successive and significant budget deficits in Italy and in Belgium had a clearly identifiable impact on government debt, with the debt-to-GDP

ratio rising steadily until the middle of the 1990s. Germany and France also exhibited a slowly growing debt ratio throughout the 1980s and 1990s. On the other hand, debt ratio at the UK followed a downward path, while Ireland changed from being a high debt country in the 1980s to a "less indebted" country in the 1990s.

[Insert Figure 2 about here]

Concerning government expenditures and revenues, Table 2 reports those items as a percentage of GDP for each country. The main conclusion is that the burden of public expenditures and revenues on GDP has increased since the 1970s in almost every country. Another obvious fact is that, , between 1970 and 2003, the ratio of government expenditures to GDP, for most countries, exhibited a higher growth rate than the ratio of government revenues to GDP. This conclusion holds for all countries except for Belgium, Ireland and Italy. For instance in Italy, the ratios of government revenues and expenditures to GDP were respectively 29 and 32.6 percent in 1970, compared with 45.9 and 48.5 percent in 2003.

[Insert Table 2 about here]

4.2. Estimation results for the debt series

The focus of this sub-section and the next, is the study of fiscal policy sustainability for each of the EU-15 countries. Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests are used in an attempt to validate the sufficient sustainability condition, using the stock of real public debt. Table 3 reports the stationarity tests results for the first difference of the stock of public debt, at 1995 prices, for the period 1970-2003 (see data sources in the Annex), considering both a constant and no trend.

[Insert Table 3 about here]

The results allow the rejection of the null of a unit root for Austria, Portugal and the UK, according to ADF tests, and for France, Germany, Greece, Ireland, Luxembourg,

Portugal, Spain and Sweden, using the PP tests. Therefore the series of the first difference of public debt might be I (0) for some countries, and the solvency condition would be satisfied in those cases. However, if one considers also a time trend, then neither the ADF nor the PP tests report that any of the series is I (0).

The previous results assume that there is no structural break in the debt series. However, this might not be the case in some countries, namely for Germany due to reunification in 1990.[12] In the presence of structural changes in the trend function, ADF and PP tests that do not take account of the break in the series have low power and are biased toward the non-rejection of a unit root. One procedure to test for unit roots in the presence of a structural break involves splitting the sample into two parts and using the unit root tests for each part. However, a resulting problem is that the degrees of freedom are diminished for each of the parts.

Therefore, following Zivot and Andrews' (1992) recursive approach, we tested the null hypothesis that the series have a unit root against the alternative of stationarity with structural change at some unknown break date denoted by T_B.[13] The break date is chosen endogenously as the value, over all possible break points,[14] which minimises the *t*-statistic for testing $\rho=1$ in the following regression:

$$Y_t = \mu + \beta t + \rho Y_{t-1} + \theta DU_t + \gamma DT_t + \delta D(T_B)_t + \sum_{i=1}^{k} c_i \Delta Y_{t-i} + \varepsilon_t . \qquad (10)$$

The shift in the trend is given by $DT_t = t\text{-}T_B$, if $t > T_B$, and 0 otherwise, and the shift in the mean by $DU_t=1$ if $t > T_B$, and 0 otherwise. T_B equals one at the observation after the break point, while the additional one-time dummy $D(T_B)_t=1$ if $t=T_B+1$ and 0 otherwise. This "innovational outlier" model specifies that the change to the new trend function is gradual. Table 4 reports the ADF test statistics proposed by both Zivot and Andrews

[12] For instance, Greiner and Semmler (1999) report a break date for Germany in 1990, while Getzner et al. (2001) mention a break date in 1975 for Austria (but with a longer historical dataset).
[13] This is a variation of the test of Perron (1988), with the advantage that the break point is estimated rather than fixed exogenously. See, for instance, Hansen (2001) for a review of these issues.
[14] Zivot and Andrews (1992) suggest estimating the autoregressions in some interval that excludes break dates near the beginning or the end of the sample.

(1992) and by Perron (1994) for the best-fitted regression, alongside the estimated break dates.[15]

[Insert Table 4 about here]

The results allow for the rejection of the unit root hypothesis for Austria, Finland and the UK, using the Zivot and Andrews test statistic, for Finland, Germany, Sweden and the UK when the Perron test statistic is used. However, in general one cannot reject the unit-root null at the 5 percent or 10 percent level, implying that there is not much evidence against the unit-root hypothesis for most of the debt series in the EU-15 countries. These results are, to some extent, in line with the standard unit-root tests reported previously in Table 3.

Since some debt series might be stationary with breaks, the selected value of TB is a consistent estimate of the break point. Interestingly, most of the reported breaks seem to cluster in the 1990s, and more specifically in the first half of the decade, namely Austria in 1991/92, Finland in 1990/91, and Germany in 1993/94. One can also notice that, for instance, in Finland the debt-to-GDP ratio increased by more than threefold between 1990 and 1992 (while there was a severe recession in 1991/92). On the other hand, the estimated break date for Germany occurs only in 1993.

One should also notice that the number of observations used is only 33 at most, and the accuracy problems of unit root tests with small samples are well known. However, the alternative approach of using quarterly data would constrain the time period, so that it is therefore preferable to use a longer sample of annual data, instead of more observations along a smaller time span. Furthermore, the rejection of the stationarity hypothesis does not mean, as already noticed above, that public accounts are not sustainable, since as Trehan and Walsh (1991) observe, 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 in the government accounts.

[15] The statistical algorithm used to compute these test statistics, following the sequential method proposed by Zivot and Andrews, was implemented with a TSP programme, available at http://www.stanford.edu/~clint/tspex/.

4.3. Co-integration results

We now proceed to study fiscal sustainability in the EU-15 countries by testing the existence of co-integration between government expenditures and revenues, taken as a percentage of GDP, and using the sequential procedure depicted in Figure 1. Visual inspection of the time series for each country may give an early clue, as can be seen by the examples in Figure 3, which depict government expenditures and revenues, as a percentage of GDP, for Italy, Germany, France and the Netherlands. One suspects in advance that Italy and France may not pass the sustainability tests.

[Insert Figure 3 about here]

The first step is then to test the existence of a unit root for the government expenditures and revenues as a percentage of GDP and to assess whether they are best characterised as I(0) or as I(1) series. The results of those tests for the series in levels are presented in Table 5.

[Insert Table 5 about here]

It is possible to conclude that almost all series are not stationary in levels. There are some exceptions where the ADF test statistic does not allow rejecting the hypothesis that the series are I (0). However, this never happened with the PP test statistic, and allowing for a trend in the regressions, both the ADF and the PP tests report that all series are non-stationary. For every country it is thus necessary to test for the stationarity of the first differences of the series.

According to the results also reported in Table 5, in general one would not reject the stationarity of the first differences of the government expenditures and revenues series. This is true for all series according to the PP test, but less generalised under the ADF test statistics results. One can then tentatively assume that the first difference of the original series is I (0), which means that the series in levels are I (1).

The Engle-Granger and Johansen co-integration tests were subsequently performed with the government revenues and expenditures as a percentage of GDP. Co-integration tests were made for all countries, even for the countries where the ADF test statistic (but not the PP test) allows rejecting the null of unit root for the first difference of the revenue and expenditure series. The co-integration results are presented in Table 6, but only for the cases where there is a co-integrating vector with at least a significance level of ten percent.

[Insert Table 6 about here]

The test results allow the rejection of the co-integration hypothesis for the majority of the countries, except for Austria, Germany, Finland, Netherlands, Portugal and the United Kingdom. However, the estimated coefficients for expenditures, in the co-integration equations, where government revenues are the dependent variable, are always less than one. As a matter of fact, for each one percentage point of GDP increase in public expenditures, for instance in the Netherlands and in Germany, public revenues only increase respectively by 0.634 and 0.521 percentage points of GDP. Notice that these two countries are the ones where the estimated coefficient *b* in the co-integrating vector (1, -b) has the highest absolute value. For the other countries where a significant co-integration vector was found, *b* is even lower in absolute value.

In other words, for the period 1970-2003, government expenditures in the abovementioned countries exhibited a higher growth rate than public revenues, challenging therefore the hypothesis of fiscal policy sustainability. These results suggest that fiscal policy may not have been sustainable for most countries with the possible exceptions of Germany and the Netherlands.

However, and as in the case of unit roots, a test for co-integration that does not take into account possible breaks in the long-run relationship will have lower power. The test will tend to under-reject the null of no co-integration if there is a co-integration relationship that has changed at some time during the sample period. Therefore, to further evaluate the

previous results, one should also entertain the possibility that the series are co-integrated but that the linear combination has shifted at an unknown point in the data sample, in other words, that there might be a relevant break date. Following Gregory and Hansen (1996), the hypothesis of a structural shift in the co-integration relationships was then studied.[16] Table 7 reports the results of the tests for regime shift (in level, with a time trend) in co-integration of government revenues and expenditures for the EU-15 countries.

[Insert Table 7 about here]

It is possible to see that for the above-mentioned countries, where a co-integration vector was found, the test statistics from Table 7 broadly support the previous findings. Indeed, accounting for the existence of break dates, the null of no co-integration is now rejected for Austria, Belgium, Denmark, Finland, the Netherlands, Portugal and the UK, with the ADF test statistic results (with the Phillips Z_α^* test statistic the null is only rejected for Belgium). This means that there is some long-run relationship in the data for those countries. Notice also that the null of no co-integration is no longer rejected for Germany. Additionally, the fact that the null hypothesis is now rejected for Belgium implies that structural changes in the co-integration vector may be important. Since for the remainder of the countries both ADF and ADF^* test statistics reject the null of no co-integration, no inference that structural change has occurred is warranted.

Our results, as most of the results reported in the literature were obtained without considering additional sources of government revenues: for instance seigniorage and privatisation revenues. Information on privatisation revenues is not easily available for the EU-15 countries. Additionally, government assets (wealth) should be taken into account to make judgements about the sustainability of public finances (even though data are mostly lacking).

[16] A Gauss routine, from Gregory and Hensen, was used to perform the tests for co-integration with regime shifts (see http://www.ssc.wisc.edu/~bhansen/progs/joe_96.html). The authors have extended the Engle-Granger model to allow for a single break in the co-integration relationship.

5. Conclusion

The fiscal policy sustainability issue has been reviewed and discussed in this paper, using the government budget constraint as the key element of the analysis, and also the starting point to derive analytical formulations suitable for empirical testing. Formally, the PVBC requires that all future net tax revenues (i.e. tax revenues less transfers of current and all future generations measured in present value terms) are enough to cover the present value of future government consumption and to service the existing stock of government debt[17].

The paper's results reveal that with few exceptions, EU governments might have sustainability problems, although debt-to-GDP ratios showed signs of stabilising at the end of the 1990s. Using government expenditures and revenues as a percentage of GDP, a co-integration approach was adopted. However, and even if a co-integration vector were identified for Austria, Germany, Finland, Netherlands and Portugal, the estimated coefficients for expenditures in the co-integration equations for those countries, where public revenues is the dependent variable, are less than one.

The results of this paper are comparable with the ones from some of the existing cross-country literature, and might be considered as "unpleasant" from a policy maker's point of view[18]. A small number of countries emerge as less likely to exhibit sustainability problems, namely Germany, Netherlands, Finland, Austria the UK. Of these, Germany and the Netherlands almost always appear as less likely to have sustainability problems. However, our results also show that even for those two countries, the absolute value of the relevant estimated coefficient in the co-integration relation is quite below unity implying that their budget deficits may not be sustainable.

Therefore, the aforementioned countries face the problem of having a higher growth rate for expenditures than the growth rate of revenues. In other words, if fiscal policy were to be conducted in the future as it was in the past, there could still be some problems ahead,

[17] One should note that it does not assume that government debt is ever paid off.
[18] See namely Vanhorebeek and van Rompuy (1995), Payne (1997), Artis and Marcelino (1998), Uctum and Wickens (2000), and Bravo and Silvestre (2002).

even for this set of countries that started, early in the 1990s, to make efforts in order to meet strict budgetary criteria. This problem may even become more critical in the light of some "unpleasant" available projections for the EU-15 countries, concerning future public financial responsibilities. As a matter of fact, the EC (2001) reported that ageing populations could lead to increased expenditure on public pensions by between 3 and 5 percentage points of GDP in most Member States, with larger increases in several countries. Moreover, recent fiscal developments during 2001-2003 in several EU countries do not seem reassuring in what terms of sustainability of public finances.

It is nevertheless important to keep in mind that the main driver for budgetary problems in developed countries during future decades will be population growth combined with generous pay-as-you-go financed social security systems. Since this population shift towards older societies is an entirely new phenomenon, it cannot be considered in econometric results based exclusively on past data. This does not constitute a general criticism against purely econometric methods of measuring fiscal sustainability, but is instead an argument for expanding the database. Indeed, implicit public pension liabilities, as part of a country's global fiscal imbalance, have to be understood as future borrowing requirements, not fully embedded in the public fiscal figures, leading therefore to added sustainability problems[19]. Also, one must recall that even for some of the countries that are identified as not having had in the past an unsustainable policy, other reports claim that sustainability may not be a feature of such countries' fiscal policies[20].

[19] For a review of this topic and some interesting data simulation see, for instance, EPC (2003), Rother et al. (2003), and Holzmann et al. (2004).
[20] See, for instance, Raffelhüschen (1999), and EC (1999, 2001).

Annex: Data sources

All data was taken from the European Commission AMECO (Annual Macro-Economic Data) database, updated on 07/01/2004. The relevant AMECO codes are reported below.

- General government public debt (national currency). Code: UDGGL (linked series).
- Price deflator private of final consumption expenditure. Code: PCPH.
- General government total revenues, national currency. Code: URTG (ESA 1995); URTGF (former definition).
- General government total expenditures, national currency. Code: UUTG (ESA 1995); UUTGF (former definition).
- Gross domestic product, at market prices. Code: UVGDH (ESA 1995); UVGD (former definition).

References

Ahmed, S. and Rogers, J. (1995). "Government budget deficits and trade deficits. Are present value constraints satisfied in long-term data?" *Journal of Monetary Economics*, 36 (2), 351-374.

Artis, M. and Marcelino, M. (1998). "Fiscal Solvency and Fiscal Forecasting in Europe," CEPR Discussion Paper 1836.

Baglioni, A. and Cherubini, U. (1993). "Intertemporal budget constraint and public debt sustainability: the case of Italy," *Applied Economics*, 25 (2), 275-283.

Bergman, M. (2001). "Testing Government Solvency and the No Ponzi Game Condition," *Applied Economics Letters*, 8 (1), 27-29.

Blanchard, O.; Chouraqui, J.; Hagemann, R. and Sartor, N. (1990). "The sustainability of fiscal policy: new answers to an old question," *OECD Economic Studies*, 15, Autumn, 7-36.

Bohn, H. (1991). "The Sustainability of Budget Deficits with Lump-Sum and with Income-Based Taxation," *Journal of Money, Credit, and Banking*, 23 (3), Part 2, 581-604.

Bohn, H. (1995). "The Sustainability of Budget Deficits in a Stochastic Economy," *Journal of Money, Credit, and Banking*, 27 (1), 257-271.

Bohn, H. (1998). "The Behavior of U. S. Public Debt and Deficits, " *Quarterly Journal of Economics*, 113 (3), 949-963.

Bravo, A. and Silvestre, A. (2002). "Intertemporal sustainability of fiscal policies: some tests for European countries," *European Journal of Political Economy*, 18 (3), 517-528.

Buiter, W. (2002). "The Fiscal Theory of the Price Level: A Critique," *Economic Journal*, 112 (481), 459-480.

Caporale, G. (1995). "Bubble finance and debt sustainability: a test of the government's intertemporal budget constraint," *Applied Economics*, 27 (12), 1135-1143.

Chalk, N. and Hemming, R. (2000). "Assessing Fiscal Sustainability in Theory and Practice," IMF Working Paper, 00/81, April.

Cuddington, J. (1997). "Analysing the Sustainability of Fiscal Deficits in Developing Countries," Policy Research Working Paper nº 1784, World Bank.

Dickey, D. and Fuller, W. (1981). "The Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root," *Econometrica*, 49, 1057-1072.

Elliot, G. and Kearney, C. (1988). "The intertemporal government budget constraint and tests for bubbles," *Research Discussion Paper* nº 8809, Reserve Bank of Australia.

EC (1999). "Generational accounting in Europe," *European Economy, Reports and Studies* 6. Office for Official Publications of the EC.

EC (2001). "The impact of ageing populations on public pension systems," *European Economy, Reports and Studies* 4. Office for Official Publications of the EC.

EPC (2003). "The impact of ageing populations on public finances: overview of analysis carried out at EU level and proposals for a future work programme," Economic Policy Committee, EPC/ECFIN/435/03, October.

Fève, P. and Hénin, P. (2000). "Assessing effective sustainability of fiscal policy within the G-7," *Oxford Bulletin of Economic Research*, 62 (2), 175-195.

Getzner, M.; Glatzer, E. and Neck, R (2001). "On the Sustainability of Austrian Budgetary Policies," *Empirica*, 28 (1), 21-40.

Gregory, A. and Hansen, B. (1996). "Residual-based tests for cointegration in models with regime shifts," *Journal of Econometrics*, 70 (1), 99-126.

Greiner, A. and Semmler, W. (1999). "An Inquiry into the Sustainability of German Fiscal Policy: Some Time Series Test," *Public Finance Review*, 27 (2), 194-220.

Greiner, A.; Koeller, U. And Semmler (2004). “Debt Sustainability in the European Monetary Union: Theory and Empirical Evidence for Selected Countries,” *mimeo*.

Hakkio, G. and Rush, M. (1991). “Is the budget deficit "too large?"” *Economic Inquiry*, 29 (3), 429-445.

Hamilton, J. and Flavin, M. (1986). “On the Limitations of Government Borrowing: A Framework for Empirical Testing,” *American Economic Review*, 76 (4), 808-816.

Hansen, B. (2001). “The New Econometrics of Structural Change: Dating Breaks in U.S. Labor Productivity,” *Journal of Economic Perspectives*, 15 (4), 117-128.

Hatemi-J, A. (2002). "Fiscal Policy in Sweden: Effects of EMU Criteria Convergence," *Economic Modelling*, 19 (1) 121-136.

Haug, A. (1991). “Cointegration and Government Borrowing Constraints: Evidence for the United States,” *Journal of Business & Economic Statistics*, 9 (1), 97-101.

Haug, A. (1995). “Has Federal budget deficit policy changed in recent years?” *Economic Inquiry*, 33 (3), 104-118.

Hénin, P. (1997). “Soutenabilité des déficits et ajustements budgétaires,” *Révue Économique*, 48 (3), 371-395.

Holzmann, R.; Palacios, R. and Zviniene, A. (2004). “Implicit Pension Debt: Issues, Measurement and Scope in International Perspective,” Social Protection Discussion Paper No. 0403, March, World Bank.

Joines, D. (1991). “How large a federal deficit can we sustain?” *Contemporary Policy Issues*, 9 (3), 1-11.

Keynes, J. (1923). *A Tract on Monetary Reform*, in *The Collected Writings of John Maynard Keynes*, vol. IV, Macmillan, 1971.

Kremers, J. (1988). “The Long-Run Limits of U. S. Federal Debt,” *Economics Letters*, 28 (3), 259-262.

Kremers, J. (1989). “U. S. federal indebtedness and the conduct of fiscal policy,” *Journal of Monetary Economics*, 23 (2), 219-238.

Liu, P. and Tanner, E. (1995). “Intertemporal solvency and breaks in the US deficit process: a maximum-likelihood cointegration approach,” *Applied Economics Letters*, 2 (7), 231-235.

MacDonald, R. (1992). “Some tests of the government's intertemporal budget constraint using US data,” *Applied Economics*, 24 (12), 1287-1292.

MacDonald, R. e Speight, A. (1990). “The intertemporal government budget constraint in the U.K., 1961-1986,” *The Manchester School*, 58 (4), 329-347.

Makrydakis, S.; Tzavalis, E. and Balfoussias, A. (1999). “Policy regime changes and long-run sustainability of fiscal policy: an application to Greece,” *Economic Modelling*, 16 (1), 71-86.

Martin, G. (2000). “US deficit sustainability: a new approach based on multiple endogenous breaks,” *Journal of Applied Econometrics*, 15 (1), 83-105.

McCallum, B. (1984). “Are Bond-Financed Deficits Inflationary? A Ricardian Analysis,” *Journal of Political Economy*, 92 (1), 123-135.

Olekalns, N. (2000). "Sustainability and Stability? Australian Fiscal Policy in the 20th Century," *Australian Economic Papers*, 39 (2), 138-151.

Owoye, O. (1995). “The causal relationship between taxes and expenditures in the G7 countries: cointegration and error-correction models,” *Applied Economic Letters*, 2 (1), 19-22.

Papadopoulos, A. and Sidiropoulos, M. (1999). "The Sustainability of Fiscal Policies in the European Union," *International Advances in Economic Research*, 5 (3), 289-307.

Payne, J. (1997). “International evidence on the sustainability of budget deficits,” *Applied Economics Letters*, 12 (4), 775-779.

Perron, P (1989). “The Great Crash, the Oil Price Shock, and the Unit Root Hypothesis,” *Econometrica*, 57 (6), 1361-1401.

Phillips, P. and Perron, P. (1988). “Testing for a Unit Root in Time Series Regression,” *Biometrika*, 75 (2), 335-346.

Perron, P. (1994). “Trend, Unit Root and Structural Change in Macroeconomic Time Series,” in *Cointegration for the Applied Economist*, Rao, B. (ed.), St. Martin’s Press.

Quintos, C. (1995). “Sustainability of the Deficit Process With Structural Shifts,” *Journal of Business & Economic Statistics*, 13 (4), 409-417.

Raffelhüschen, B. (1999). “Generational Accounting in Europe,” *American Economic Review, Papers and Proceedings*, 89 (2), 167–170.

Rother, P.; Catenaro, M; and Schwab, G. (2003). “Ageing and Pensions in the Euro Area Survey and Projection Results,” Social Protection Discussion Paper No. 0307, March, World Bank.

Smith, G. and Zin, S. (1991). “Persistent Deficits and the Market Value of Government Debt,” *Journal of Applied Econometrics*, 6 (1), 31-44.

Tanner, E. and Liu, P. (1994). “Is the budget deficit "too large?": some further evidence,” *Economic Inquiry*, 32, 511-518.

Trehan, B. and Walsh, C. (1988). “Common trends, the government's budget constraint, and revenue smoothing,” *Journal of Economic Dynamics and Control*, 12 (2/3), 425-444.

Trehan, B. and Walsh, C. (1991). “Testing Intertemporal Budget Constraints: Theory and Applications to U.S. Federal Budget and Current Account Deficits,” *Journal of Money, Credit, and Banking*, 23 (2), 206-223.

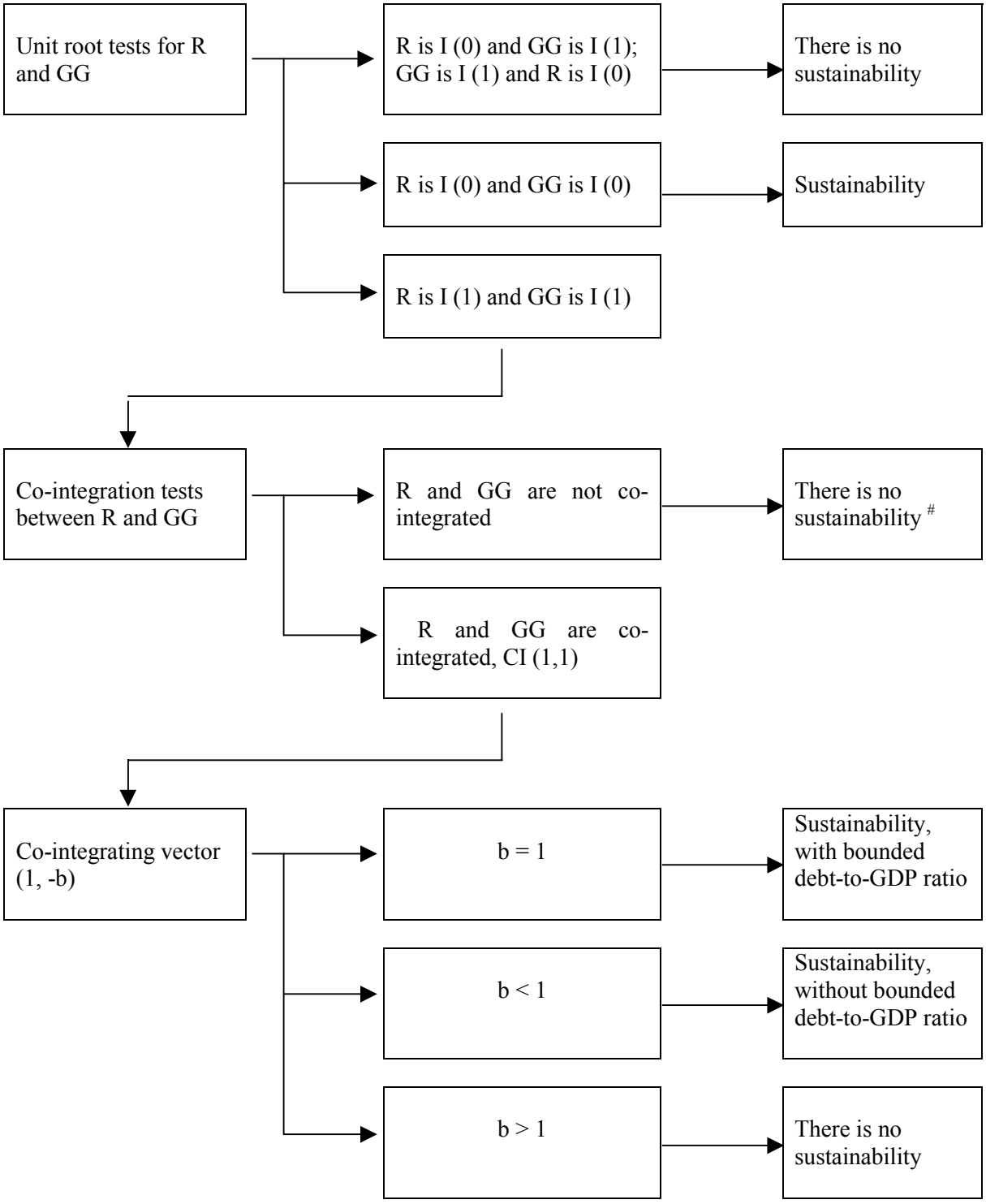
Uctum, M. and Wickens, M. (2000). “Debt and deficit ceilings, and sustainability of fiscal policies: an intertemporal analysis,” *Oxford Bulletin of Economic Research*, 62 (2), 197-222.

Vanhorebeek, F. and van Rompuy, P. (1995). "Solvency and sustainability of fiscal policies in the EU," *De Economist*, 143 (4), 457-473.

Wilcox, D. (1989). “The Sustainability of Government Deficits: Implications of the Present-Value Borrowing Constraint,” *Journal of Money, Credit, and Banking*, 21 (3), 291-306.

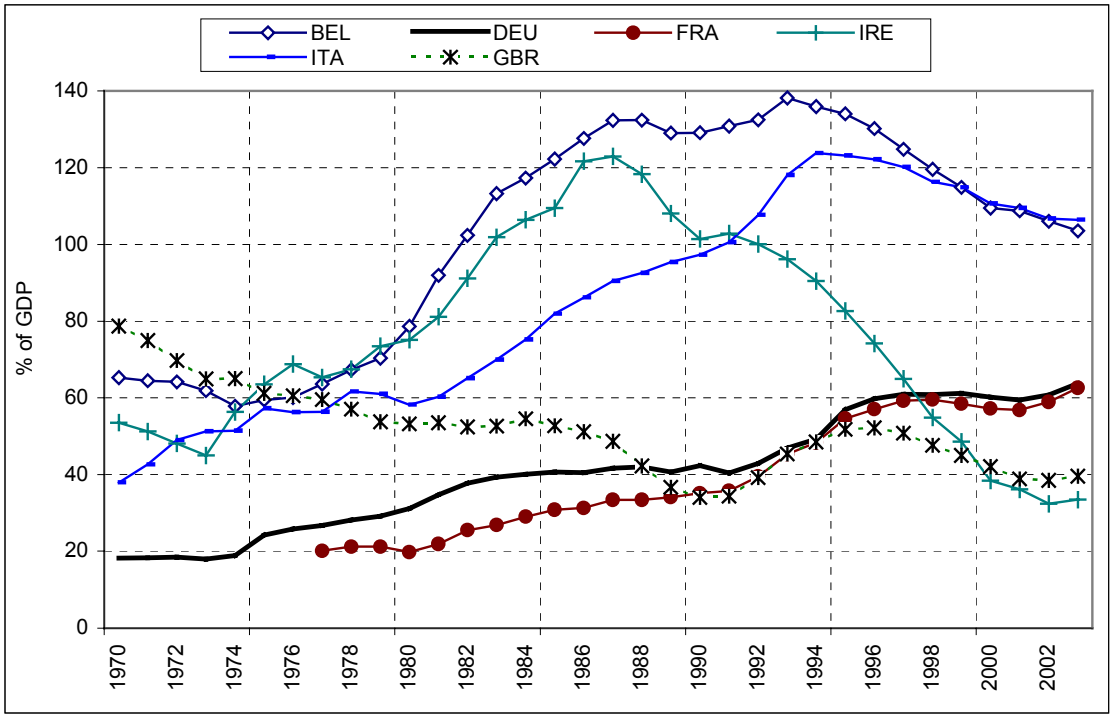
Zivot, E. and Andrews, D. (1992). “Further Evidence on the Great Crash, the Oil-Price Schock, and the Unit-Root Hypothesis,” *Journal of Business and Economic Statistics*, 10 (3), 251-270.

Figure 1. Fiscal policy sustainability, unit root and co-integration tests



[#] Even if there is no co-integration, sustainability might not be a problem if, for instance, revenues are higher than expenditures.

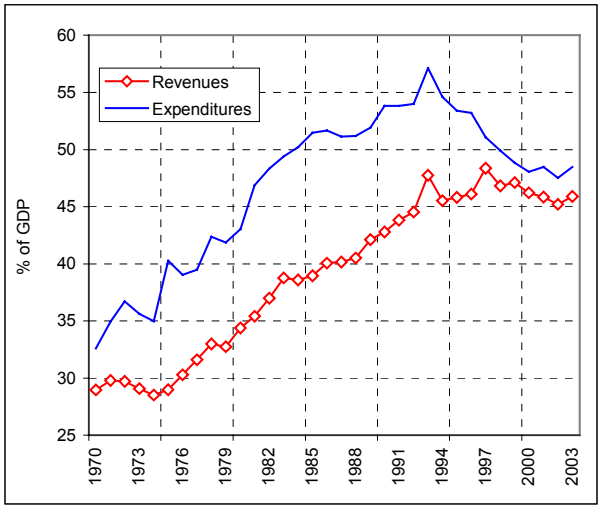
Figure 2. Public debt in some EU countries (percent of GDP)



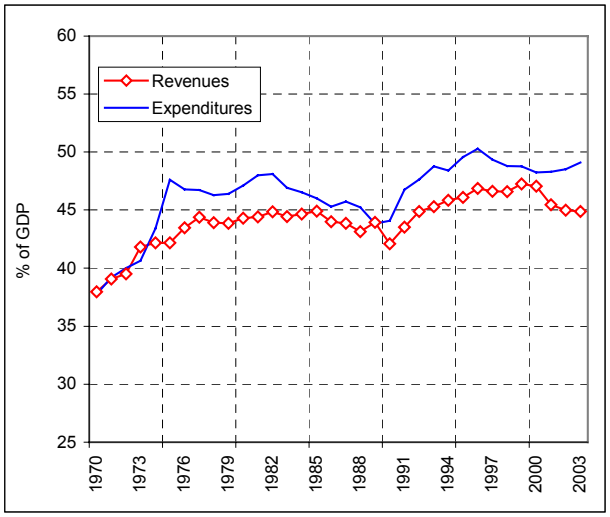
Source: European Commission, AMECO database (updated on 07/01/2004).

Figure 3. Government expenditures and revenues (percent of GDP)

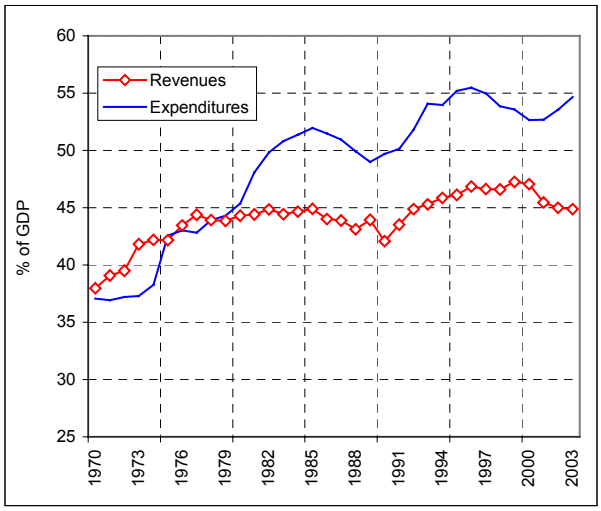
3a. Italy



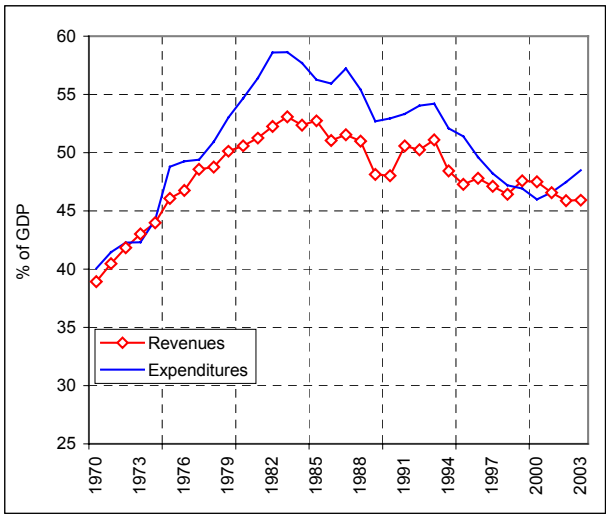
3b. Germany



3c. France



3d. Netherlands



Source: European Commission, AMECO database (updated on 07/01/2004).

Table 1. Some existing empirical evidence regarding fiscal policy sustainability

Author and date	Data frequency	Period and country	Tests performed	Sustainability?
Hamilton and Flavin (1986)	Annual	1962-1984 (US)	Stationarity tests (deficit and public debt)	Yes
Trehan and Walsh (1988)	Annual	1890-1983 (US)	Stationarity tests (deficit)	Yes
Kremers (1988)	Annual	1920-1985 (US)	Stationarity tests (public debt)	Yes until 1981, no afterwards
Elliot and Kearney (1988)	Annual	1953/54-1986/87 (Australia)	Public revenues and expenditures co-integration	Yes
Wilcox (1989)	Annual	1960-1984 (US)	Stationarity test (public debt)	No
MacDonald and Speight (1990)	Annual	1961-1986 (UK)	Stationarity tests (public debt); deficit and debt co-integration	Inconclusive
Hakkio and Rush (1991)	Quarterly	1950:II-1988:IV (US)	Public revenues and expenditures co-integration	No
Smith and Zin (1991)	Monthly	1946:1-1984:12 (Canada)	Stationarity tests (deficit and public debt), co-integration	No
Trehan and Walsh (1991)	Annual	1960-1984 (US)	Stationarity tests (deficit and public debt)	Yes
MacDonald (1992)	Monthly	1951:1-1984:12 (US)	Stationarity test s (public debt); deficit and debt co-integration	No
Baglioni and Cherubini (1993)	Monthly	1979:1-1991:5 (Italy)	Stationarity tests (deficit and public debt)	No
Tanner and Liu (1994)	Annual	1950-1989 (US)	Public revenues and expenditures co-integration	Yes, with a break in 1982
Liu and Tanner (1995)	Quarterly	? -1991:IV (US)	Public revenues and expenditures co-integration	Yes, with a break in 1982
Caporale (1995)	Semi-annual and annual	1960-1991 (EU countries)	Stationarity tests (deficit and public debt)	No for Italy, Greece, Denmark and Germany
Quintos (1995)	Quarterly	1947:II-1992:III (US)	Public revenues and expenditures co-integration	Yes until 1980, no afterwards
Haug (1995)	Quarterly	1950:I-1990:IV (US)	Public revenues and expenditures co-integration	Yes
Ahmed and Rogers (1995)	Annual	1692-1992 (US) 1792-1992 (UK)	Public revenues and expenditures co-integration	Yes
Vanhorebeek and van Rompuy (1995)	Annual	1970-1994 (8 EU countries) 1870-1993 (Belgium)	Stationarity tests (deficit and public debt)	Yes for Germany and France
Owoye (1995)	Annual	1961-1990 (G7 countries)	Causality between taxes and spending	bi-directional in five G7 countries
Payne (1997)	Annual	1949-1994 (G7 countries)	Public revenues and expenditures co-integration	Yes for Germany
Artis and Marcelino (1998)	Annual	1963-1994 EU countries	Stationarity tests (public debt)	Yes, for Austria, Netherlands, UK
Bohn (1998)	Annual	1916-1995 (US)	Relationship between primary surpluses and debt ratio	Yes
Makrydakis (1999)	Annual	1958-1995	Stationarity tests (public debt)	No

		(Greece)		
Papadopoulos and Sidiropoulos (1999)	Annual	1961-1995 (4 European countries)	Public revenues and expenditures co-integration	Yes for Greece and Spain

Table 1. (continued)

Author and date	Data frequency	Period and country	Tests performed	Sustainability?
Greiner and Semmler (1999)	Annual	1955-1994 Germany	Stationarity tests (public debt)	No
Olekalns (2000)	Annual and quarterly	1900/01-1994/95 1978:3-1997:4 (Australia)	Public revenues and expenditures co-integration	No
Fève and Hénin (2000)	Semi-annual	(G-7 countries)	Stationarity tests (public debt)	Yes for US, UK and Japan
Uctum and Wickens (2000)	Annual	1965-1994 (US and 11 EU countries)	Stationarity tests (public debt)	Yes for Denmark, Netherlands, Ireland and France
Martin (2000)	Annual	1947-1992 (US)	Public revenues and expenditures co-integration	Yes, with breaks in the 70s and 80s
Getzner, Glatzer and Neck (2001)	Austria	1960-1999	Stationarity tests (central public debt)	Yes for 1960-1974, no for 1975-1999
Bravo and Silvestre (2002)	Annual	1970-1997 (EU countries)	Public revenues and expenditures co-integration	Yes for Germany, Austria, Finland, UK, Netherlands
Hatemi-J (2002)	Quarterly	1963:I-2000:I (Sweden)	Public revenues and expenditures co-integration	Yes
Greiner, Koeller and Semmler (2004)	Annual	1960-2003 (Germany, France, Italy, Portugal and US)	Relationship between primary surpluses and debt ratio	Yes

Table 2. General government revenues and expenditures, EU-15 (percent of GDP)

Country	Revenues and Expenditures	1970 (1)	1980	1990	2000	2003 (2)	Δ in pp (2)-(1)
Austria	Revenues	39.1	45.6	47.1	50.8	50.2	11.2
	Expenditures	37.9	47.2	49.6	52.6	51.2	13.3
Belgium	Revenues	38.7	47.6	47.5	49.5	51.4	12.7
	Expenditures	40.8	56.1	52.9	49.3	51.1	10.3
Denmark	Revenues	44.8	49.9	55.1	57.2	56.4	11.6
	Expenditures	40.8	53.1	56.1	54.6	55.4	14.6
Finland	Revenues	34.1	42.0	51.3	56.1	53.4	19.3
	Expenditures	29.9	38.7	46.0	49.0	50.9	21.0
France	Revenues	37.9	45.3	48.2	51.3	50.5	12.6
	Expenditures	37.1	45.4	49.7	52.7	54.7	17.6
Germany	Revenues	38.0	44.3	42.1	47.1	44.9	6.9
	Expenditures	37.7	47.1	44.1	48.2	49.1	11.4
Greece	Revenues	24.7	26.3	32.5	47.8	44.6	19.9
	Expenditures	24.2	29.0	48.4	49.8	46.3	22.1
Ireland	Revenues	30.3	34.5	35.9	36.5	34.0	3.6
	Expenditures	34.2	46.1	38.0	32.1	34.8	0.6
Italy	Revenues	29.0	34.4	42.8	46.2	45.9	16.9
	Expenditures	32.6	43.0	53.8	48.1	48.5	15.9
Luxembourg	Revenues	31.7	48.0		44.9	47.5	15.7
	Expenditures	28.9	48.4		38.5	48.2	19.3
Netherlands	Revenues	38.9	50.6	48.0	47.5	45.9	7.0
	Expenditures	40.1	54.7	53.0	46.0	48.5	8.4
Portugal	Revenues	22.5	27.8	33.9	42.3	44.2	21.7
	Expenditures	19.7	36.2	38.8	45.4	47.1	27.4
Spain	Revenues	21.3	29.0	38.4	39.0	39.8	18.5
	Expenditures	20.7	31.5	42.6	39.9	39.8	19.1
Sweden	Revenues	46.3	56.1	62.6	60.9	59.2	12.8
	Expenditures	42.1	60.0	58.5	57.4	59.0	16.9
UK	Revenues	39.9	39.8	38.3	40.8	40.0	0.2
	Expenditures	36.9	43.2	39.2	39.3	42.8	5.9

Notes: pp - percentage points. UMTS revenues are excluded from the numbers.
Source: European Commission, AMECO database (updated on 07/01/2004).

Table 3. Stationarity tests for the first difference of the stock of public debt, with constant, no trend (at 1995 prices)

Country	Period	lags	ADF		PP	
			(tau) Test statistic	P-value	(z) Test statistic	P-value
Austria	1970-2003	3	-4.00 ***	0.00	-16.15	0.03
Belgium	1970-2003	5	-1.08	0.72	-4.05	0.53
Denmark	1971-2003	2	-2.26	0.19	-9.97	0.14
Finland	1970-2003	3	-2.41	0.14	-10.34	0.12
France	1977-2003	2	-2.50	0.12	-11.44 *	0.10
Germany	1970-2003	2	-2.50	0.13	-17.48 **	0.02
Greece	1970-2003	2	-2.38	0.15	-26.89 ***	0.00
Ireland	1970-2003	5	-0.91	0.78	-18.35 **	0.02
Italy	1970-2003	2	-1.20	0.67	-6.53	0.31
Luxembourg	1970-2003	2	-1.86	0.35	-13.45 *	0.06
Netherlands	1975-2003	2	-1.21	0.67	-7.71	0.24
Portugal	1973-2003	2	-3.77 ***	0.00	-29.11 ***	0.00
Spain	1970-2003	5	-2.02	0.28	-14.44 **	0.05
Sweden	1970-2003	2	-2.50	0.12	-13.93 **	0.05
United Kingdom	1970-2003	5	-3.13 *	0.10	-9.05	0.50

Note: The symbols *, **, and *** denote statistical significant at the 10%, 5%, and 1% level respectively.

Table 4. Test for structural change in general government debt, (innovational outlier model)

Country	Period	Zivot and Andrews			*Perron*		
		Break date	**ADF break point test**	**lags**	**Break date**	**ADF break point test**	**lags**
Austria	1970-2003	1992	-5.04 **	1	1991	-3.71	2
Belgium	1970-2003	1991	-3.81	1	1988	-3.13	1
Denmark	1971-2003	1993	-3.50	2	1989	-3.63	2
Finland	1970-2003	1991	-8.18 ***	1	1990	-9.84 ***	0
France	1977-2003	1988	-3.88	2	1988	-3.72	2
Germany	1970-2003	1994	-3.28	0	1993	-4.25 **	0
Greece	1970-2003	1978	-2.66	0	1991	-1.97	0
Ireland	1970-2003	1985	-4.00	0	1984	-3.85	0
Italy	1970-2003	1991	-2.39	1	1990	-2.33	1
Luxembourg	1970-2003	1986	-3.37	1	2000	-1.53	1
Netherlands	1975-2003	1991	-3.17	0	1986	-2.59	0
Portugal	1973-2003	1984	-4.34	0	1991	-3.78	1
Spain	1970-2003	1992	-2.87	0	1991	-2.80	0
Sweden	1970-2003	1997	-3.87	2	1999	-4.56 ***	2
United Kingdom	1970-2003	1987	-6.09 ***	2	1986	-6.30 ***	2

Note: The symbols *, **, and *** denote statistical significant at the 10%, 5%, and 1% level respectively, using the critical values from Zivot and Andrews (1992, table 4)

Table 5. Stationary of government revenues and expenditures (percent of GDP), with constant, no trend

Country	Variable	Original series					First difference of the original series				
			ADF		PP			ADF		PP	
		Lags	(tau) Test statistic	P-value	(z) Test statistic	P-value	Lags	(tau) Test statistic	P-value	(z) Test statistic	P-value
Austria	R	2	-1.87	0.35	-2.42	0.73	3	-2.64*	0.09	-32.05***	0.00
	GG	2	-2.78*	0.06	-3.39	0.61	2	-2.19	0.21	-31.78***	0.00
Belgium	R	2	-3.19**	0.02	-3.77	0.56	2	-2.10	0.25	-28.36***	0.00
	GG	4	-3.31**	0.02	-5.33	0.40	2	-2.13	0.23	-19.53**	0.01
Denmark	R	2	-1.46	0.55	-1.77	0.81	2	-2.86**	0.05	-29.00***	0.00
	GG	3	-3.24**	0.02	-3.23	0.63	2	-2.62*	0.09	-19.50**	0.01
Finland	R	5	-1.07	0.73	-2.21	0.76	5	-3.31**	0.01	-17.72**	0.02
	GG	3	-1.99	0.29	-2.98	0.66	3	-2.42	0.14	-15.24**	0.04
France	R	2	-2.30	0.17	-1.96	0.78	2	-2.45	0.13	-19.17**	0.01
	GG	3	-2.56	0.11	-2.19	0.76	5	-2.03	0.27	-17.65**	0.02
Germany	R	2	-3.16**	0.02	-6.18	0.33	2	-2.67*	0.08	-29.82***	0.00
	GG	2	-3.06**	0.03	-6.49	0.31	2	-2.69*	0.08	-20.25**	0.01
Greece	R	2	-0.41	0.91	0.05	0.96	2	-2.77*	0.06	-27.70***	0.00
	GG	3	-2.35	0.16	-1.40	0.85	2	-2.81*	0.06	-38.15***	0.00
Ireland	R	2	-2.17	0.22	-5.41	0.40	2	-2.92**	0.04	-36.25***	0.00
	GG	3	-1.60	0.48	-4.32	0.50	2	-3.24**	0.02	-22.34**	0.01
Italy	R	3	-1.65	0.46	-1.02	0.88	2	-3.20**	0.02	-36.20***	0.00
	GG	5	-1.64	0.46	-3.41	0.61	4	-1.75	0.41	-36.47***	0.00
Netherlands	R	2	-2.25	0.19	-5.72	0.37	2	-2.34	0.16	-24.25***	0.00
	GG	3	-2.68*	0.08	-4.55	0.48	2	-1.80	0.38	-14.55**	0.05
Portugal	R	4	-1.07	0.73	-0.09	0.95	3	-3.89**	0.00	-20.48**	0.01
	GG	2	-2.12	0.24	-2.63	0.70	2	-2.95**	0.04	-23.88***	0.00
Spain	R	2	-1.86	0.35	-1.23	0.86	3	-1.63	0.50	-32.58***	0.00
	GG	3	-2.56*	0.10	-2.19	0.76	3	-1.47	0.55	-17.32**	0.02
Sweden	R	5	-3.45***	0.01	-4.17	0.52	5	-2.17	0.22	-19.82**	0.01
	GG	5	-3.37***	0.01	-4.80	0.45	2	-1.94	0.31	-21.99**	0.01
United Kingdom	R	3	-2.11	0.24	-9.33	0.16	3	-3.26**	0.02	-17.88**	0.02
	GG	3	-3.87***	0.00	-10.10	-0.14	2	-2.57*	0.10	-15.65**	0.03

Notes: The symbols *, **, and *** denote statistical significant at the 10%, 5%, and 1% level respectively. Unit root tests were not carried out for Luxembourg since there were no data available in the AMECO database between 1988 and 1994. Some consistency in the asterisk signals for the significance levels may be lost due to rounding.

Table 6. Co-integration of government revenues and expenditures (percent of GDP)

Country	Dependent variable	Engle-Granger (tau) co-integration test		Johansen (trace) co-integration test	
		Vector	P-valueAsy	Vector	P-valueAsy
Austria	R	[1 -0.380]***	0.008	[1 -0.418]**	0.035
	GG	[1 -1.609]*	0.084	[1 -2.395]**	
Germany	R	[1 -0.521]**	0.020	[1 -0.629]**	0.017
	GG	[1 -1.272]**	0.018	[1 -1.589]**	
Finland	R	[1 -0.343]**	0.022	[1 -0.368]*	0.070
	GG	-	-	[1 -2.719]*	
Netherlands	R	[1 -0.634]**	0.037	[1 -0.665]**	0.016
	GG	[1 -1.455]*	0.100	[1 -1.505]**	
Portugal	R	[1 -0.205]***	0.004	[1 -0.174]***	0.009
	GG	-	-	[1 -5.740]***	
United	R	-	-	-	
Kingdom	GG	[1 –0.516]**	0.044	[1 -0.735]**	0.017

Notes: The symbols *, **, and *** denote statistical significant at the 10%, 5%, and 1% level respectively. Only co-integrating vectors with at least a 10% significance level are reported.

Table 7. Testing for regime shifts in co-integration of government revenues and expenditures (percent of GDP), level shift with time trend

Country	*ADF test*			Phillips test		
	ADF* statistic	**Break point**	**Estimated break date**	**Z_α* statistic**	**Break point**	**Estimated break date**
Austria	-5.47 **	(0.79)	1997	-28.65	(0.76)	1996
Belgium	-4.86 *	(0.82)	1998	-80.20 ***	(0.53)	1996
Denmark	-5.14 **	(0.41)	1984	-24.41	(0.41)	1984
Finland	-4.58 **	(0.21)	1977	-20.89	(0.15)	1975
France	-3.71	(0.62)	1991	-21.95	(0.62)	1991
Germany	-3.98	(0.18)	1976	-26.37	(0.56)	1989
Greece	-4.45	(0.76)	1996	-25.46	(0.76)	1996
Ireland	-3.32	(0.38)	1983	-20.73	(0.35)	1982
Italy	-3.73	(0.59)	1990	-19.26	(0.59)	1990
Netherlands	-4.75 *	(0.15)	1975	-25.06	(0.15)	1975
Portugal	-5.59 ***	(0.15)	1975	-27.56	(0.15)	1975
Spain	-4.23	(0.47)	1986	-24.96	(0.71)	1994
Sweden	-4.41	(0.65)	1992	-21.44	(0.65)	1992
United Kingdom	-4.75 *	(0.53)	1988	-21.05	(0.53)	1988

Notes: ADF* and Z_α* refer to the augmented Dickey-Fuller (ADF) and to the Phillips Z_α* test statistics. The symbols *, **, and *** denote statistical significant at the 10%, 5%, and 1% level respectively, using the critical values from Gregory and Hansen (1996, table 1).