

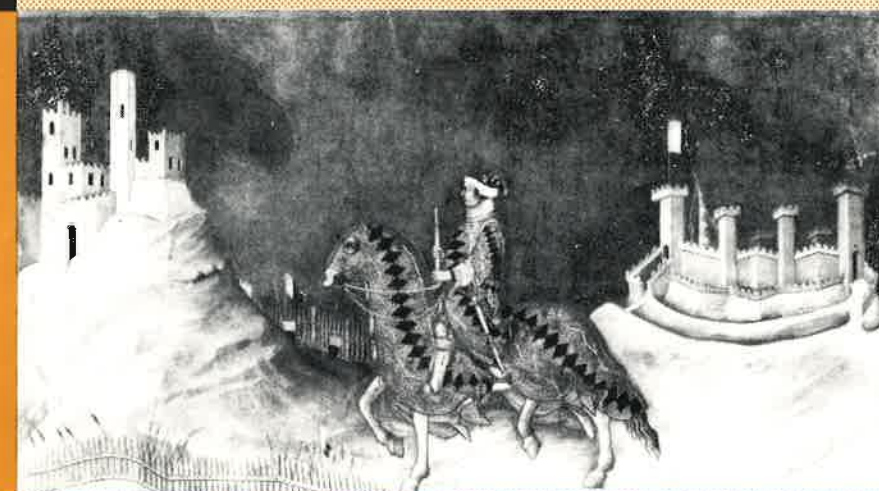
UNIVERSITA' DEGLI STUDI DI SIENA



QUADERNI DEL DIPARTIMENTO  
DI ECONOMIA POLITICA

Raul de Luzenberger  
Giancarlo Marini

**THE SUSTAINABILITY OF PUBLIC DEBT :  
TESTS AND INDICATORS**



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Raul de Luzenberger  
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THE SUSTAINABILITY OF PUBLIC DEBT:  
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Siena, dicembre 1990



# **The Sustainability of Public Debt: Tests and Indicators**

**Raul de Luzenberger**

**Giancarlo Marini**

## **ABSTRACT**

This paper presents a direct test for debt sustainability together with a strategy to integrate the results from tests and indicators of government solvency. An application to US data re-establishes the result of a sustainable course of fiscal policy and shows that the negative values of indicators reflect cyclical factors.

## **1. Introduction**

The issue of the sustainability of fiscal policy has attracted increasing interest in recent years. Two possible strategies for an empirical evaluation, based on the intertemporal budget constraint, appear to be worth pursuing. One is to construct indicators of the sustainability of fiscal policy. The other is to implement tests for solvency.

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The indicators proposed in the literature<sup>1</sup> are either simple measures mainly based on current information, or summary values of model based projections of future paths of fiscal policy. The testing techniques so far employed are mainly unit roots tests. These tests, however, are only indirect and may be subject to small sample bias<sup>2</sup>.

The aim of the present paper is twofold. First, we propose a direct test of debt sustainability, based on West's (1987) work on speculative bubbles. Secondly, we suggest a simple strategy to integrate the use of indicators and tests.

The scheme of the paper is as follows. Section 2 briefly reviews some recent indicators of sustainability. In Section 3 we present a procedure to test directly for solvency. Section 4 describes the strategy proposed to combine the use of indicators and tests. An application to the US data set constructed by Hamilton and Flavin (1986) is presented in Section 5. Section 6 summarises the main conclusions.

## 2. Indicators of Sustainability

The "law of motion" of interest bearing public debt derived from the intertemporal budget constraint is given by<sup>3</sup>:

$$(1) \quad b_t = (1 + \rho - n)b_{t-1} - s_t$$

where  $\rho$  is the real rate of return on public debt,  $n$  is the rate of growth of real output,  $b$  is the interest bearing public debt net of public assets and  $s_t$  is the primary surplus inclusive of seigniorage revenues. Both  $b$

1 See Miller (1983), Buiter (1985, 1987), Blanchard (1990).

2 See for example Schwert (1987, 1989).

3 Equation (1) is only an approximation. In the correct formula the coefficient of  $b_{t-1}$  is divided by  $(1+n)(1+\pi)^{-1}$ . Since  $n$ , the rate of growth of real GNP, and  $\pi$ , the rate of inflation, are usually small, the ratio is almost equal to the numerator.

and  $s$  are ratios to GDP<sup>4</sup>.

Solving forward equation (1) for net public debt as a function of future surpluses and of the public debt at the terminal date  $N$ , one obtains:

$$(2) \quad b_t = \left[ \sum_{i=1}^N (1 + \rho - n)^{-i} s_{t+i} \right] + (1 + \rho - n)^{t-N} b_N$$

Equation (2) implies that when the rate of growth of the economy is greater than the real rate of interest, deficits can always be financed. Hence, "honest" Ponzi games are possible and no problem of solvency arises.

Both equations (1) and (2) have been used to construct indicators of sustainability. Buiter (1985) proposes measures based on the "net worth" approach. More recently, Blanchard (1990) suggests the use of two indicators designed to tackle the issue over different time horizons. The first indicator, called the *primary gap*, is given by:

$$(3) \quad PG_t = s_t - (\rho - n)b_t$$

The primary gap is equal to the primary surplus plus the effect of the debt on the new debt creation.

The second indicator measures the *tax gap*, that is, the change in the

4 Ideally, one would like to derive equation (1) from the "net-worth" approach. Unfortunately, reliable statistics on public assets are seldom available. Hence, equation (1) usually includes only interest bearing public debt. Indicators and tests are, thus, biased towards the no-solvency hypothesis and should be evaluated accordingly.

tax rate that would be necessary to bring the ratio of public debt to GDP at the current level after a given number of years. The tax gap for a period of  $j$  years is given by:

$$(4) \quad \tau_j^* = (\rho - n) [1 - e^{-(\rho - n)j}]^{-1} \int_0^j g e^{-(\rho - n)x} dx + b_0$$

where  $\tau_j^*$  is the tax gap,  $g$  is public expenditure inclusive of transfers,  $b_0$  is public debt at the initial date and  $x$  is a time index<sup>5</sup>. Blanchard suggests to construct this indicator for a small value of  $j$ , like three or five years, and for a high value of  $j$ , like twenty or fifty years.

In what follows, we are mainly concerned with indicators like the real primary surplus, the primary gap and the three or five years tax gap for the reason that they are mainly based on current conditions and attempt to give simple "model free"<sup>6</sup> measures of government solvency. Longer term measures of sustainability, like the twenty or fifty years tax gap, require the full specification of the underlying model. The evaluation of this type of indicators is beyond the scope of the present work.

### 3. Tests for Solvency

Tests for solvency based on the present value budget constraint have originally been proposed by Hamilton and Flavin (1986). The authors point out the similarity of equation (2) with the model of self-fulfilling hyperinflations proposed by Flood & Garber (1980). Equation (2) is an identity and it is always satisfied ex-post. However, it is possible to test

<sup>5</sup> Blanchard points out that a similar indicator can also be constructed to evaluate the expenditure gap, and, it may be added, the seigniorage gap.

<sup>6</sup> Gramlich (1990) stresses the importance of model free measures of sustainability in order to avoid "additional disagreement" among policy makers.

whether government creditors perceive it as solvent. This can be done by considering the ex-ante evaluation of (2), and testing the hypothesis that agents evaluate  $b_t$  as tending to:

$$(2a) \quad b_t = \sum_{i=1}^{\infty} (1 + \rho - n)^{-i} E[s_{t+i}/\Omega_t]$$

where  $\Omega_t$  is the information set available at time  $t$ . Equation (2a) implies that agents expect the present value of real public debt-GDP ratio to approach zero as  $N$  tends to infinity, that is:

$$(2b) \quad \lim_{N \rightarrow \infty} (1 + \rho - n)^{-N} E[b_N/\Omega_t] = 0$$

Equation (2b) is formally equivalent to the condition for ruling out bubbles in Flood and Garber's model, and can be tested along the same lines.

A second test can be derived by noting that (2a) implies that  $b_t$  and  $s_t$  are integrated of the same order<sup>7</sup>, as shown by Hamilton and Whiteman (1985). This implication can be tested using standard unit roots tests. The latter approach, unlike Flood and Garber's, does not require any assumption on the level of the real interest rate and on the form of the AR representation of the surplus. However, unit roots tests are only indirect tests of the sustainability hypothesis, and may not perform satisfactorily in small samples.

On the other hand, a direct test for debt sustainability can be derived

<sup>7</sup> This condition implies also that the surplus and the debt are co-integrated with a co-integrating vector  $(1, -\rho)$ , so that government balance is stationary. See Attanasio and Marini (1988) and Diba (1989).

employing the methodology recently proposed by West (1987) for testing the existence of speculative bubbles. Consider the following autoregressive representation of the surplus:

$$(5) \quad s_{t+1} = \alpha_0 + \alpha_1 s_t + \alpha_2 s_{t-1} + \dots + \alpha_q s_{t-q+1} + v_{t+1}$$

$$v_{t+1} = e_t + m_{t+1}$$

$$e_t = [E(s_{t+1}/\Omega_t) - E(s_{t+1}/\Phi_t)]$$

where the  $\alpha$ 's are parameters and  $\Phi_t$  is the subset of  $\Omega_t$  including only present and lagged values of the surplus. Equation (5) should be specified either in levels or in first differences, according to what is necessary to achieve stationarity. Substituting the forecasts based on (5) in equation (2a) and applying the formula derived by Hansen and Sargent (1981) to solve (2a) for the past and present values of the surplus, one obtains<sup>8</sup>:

$$(6) \quad b_{t+1} = \delta_0 + \delta_1 s_{t+1} + \delta_2 s_t + \dots + \delta_q s_{t-q+1} + u_{t+1}$$

$$u_{t+1} = \left[ \sum_{i=1}^{\infty} f^i e_{t+i+1} \right] + w_t$$

where  $\delta$ 's are parameters resulting from highly non linear combinations of the  $\alpha$ 's and of the discount factor  $f$ <sup>9</sup>. An unrestricted version of the

8 When the surplus equation is specified in the differencies, it is also convenient to specify the debt equation in the same way.

9 The exact form of the non linear constraints can be found in West (1987).

model (5-6) can be estimated using OLS<sup>10</sup> to yield, under the null, consistent and fully efficient estimates of the parameters. Using equation (2), rewritten in the form:

$$(7) \quad b_t = f(b_{t+1} + s_{t+1})$$

it is also possible to obtain an instrumental variables estimate of  $f$ . This estimate is consistent under both the null hypothesis of sustainability and the alternative, and can be combined with the OLS estimates of the parameters in (5-6) to perform a Wald test of the non linear restriction implied by (2a-b). The test statistics is given by:

$$(8) \quad WT = R(\theta)' [R'(\theta) V R'(\theta)]^{-1} R(\theta)$$

where  $R$  is the vector of restrictions,  $\theta$  is the vector of the unrestricted estimates of the parameters and  $V$  is the variance-covariance matrix of parameter estimates. The advantages of this procedure is that it is based on fully efficient estimates of model (5-6) and that it does not require a-priori assumptions on the real interest rate.

Another consistent and asymptotically efficient estimate of  $f$  can be derived, under the alternative, by estimating jointly (5) and (6) by non linear methods imposing all the restrictions implied by the model<sup>11</sup>. This

10 When  $\Phi_t \equiv \Omega_t$ , OLS are fully efficient. Otherwise it is:

$$u_t = \frac{1}{f} u_{t-1} - e_t$$

Thus, OLS estimates would still be consistent, but not efficient. A consistent estimate of their covariance matrix can be obtained as in Newey-West (1987).

11 This can be done by employing NLSURE if  $\Phi_t \equiv \Omega_t$ , or NL3SLS in the more general case. See Casella (1989).



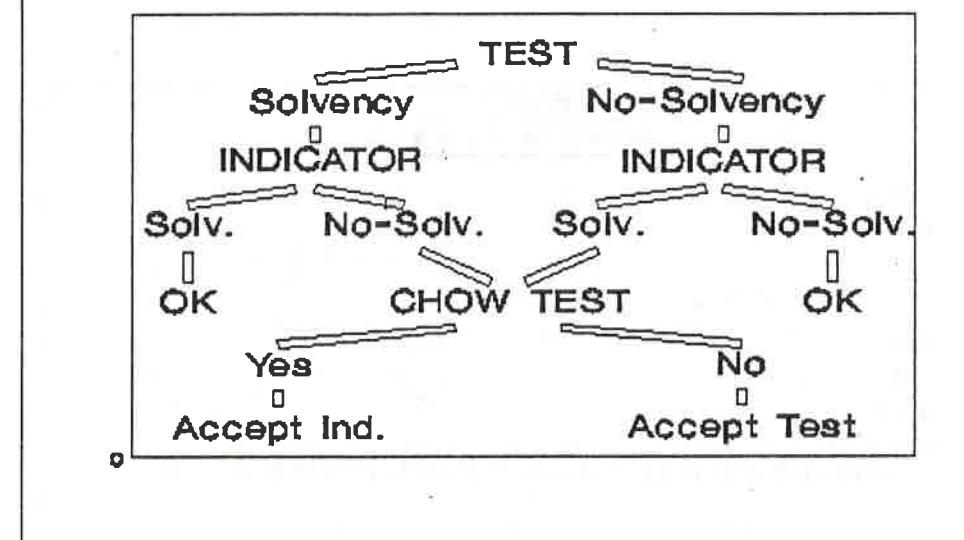
estimate is, however, inconsistent under the hypothesis of non-sustainability. The Hausman (1978)'s specification test permits to evaluate the difference between the two estimates of  $f$ . If the difference is statistically insignificant the hypothesis of non-sustainability is rejected. This procedure allows for a further check on the results from West's test and on the specification of the model.

#### 4. Combining the two approaches

The simultaneous use of tests and indicators provides additional information on the issue of government solvency. Indicators respond to a set of current conditions and do not possess long memory. Tests, on the other hand, although implicitly generating forecasts, always rely on a sample of past data. For this reason, indicators may be quicker than tests in responding to changes in the policy regime.

The two approaches could usefully be integrated. A possible strategy is shown in figure 1. The basic idea is that tests and indicators simply reinforce each other when their predictions are not in conflict. In other words, when both tests and indicators (do not) show the existence of a solvency problem, (no) some correction in the fiscal stance is required. In the case of conflicting results, their interpretation is unclear. Indicators may signal the occurrence of a change in policy which may reverse the predictions of tests. A change in regime should, however, cause a structural break in the data generating process of the surplus, which can be detected using, e.g., a Chow test on the stability of the parameters of the surplus equation. Whether the results from indicators or from tests should be given priority in the assessment of the sustainability of public debt depend thus on the stability of the surplus equation.

FIGURE 1



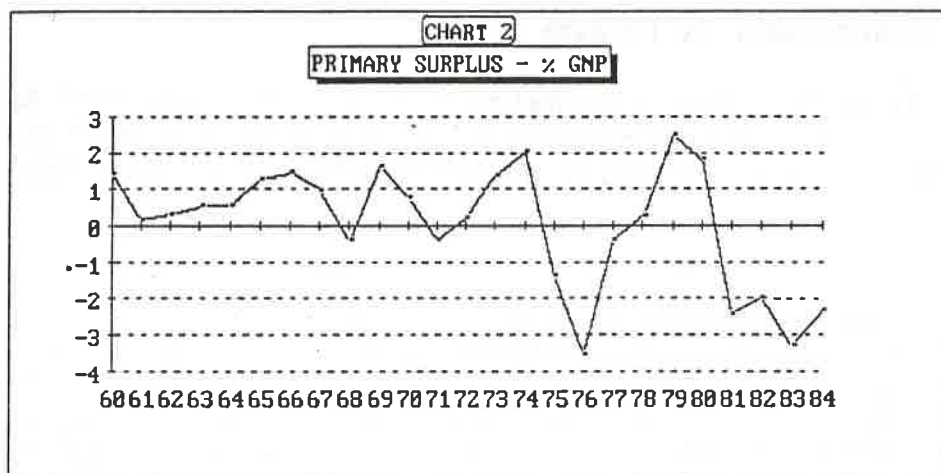
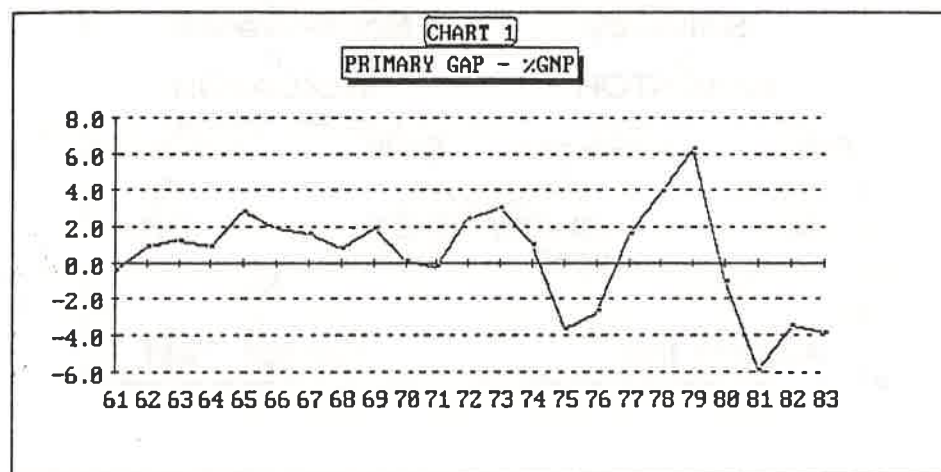
#### 5. An application to US data

We apply the strategy suggested to the US over the period 1960-84, using the data set constructed by Hamilton and Flavin (1986)<sup>12</sup>. The primary surplus, computed by the authors, is shown in chart 1. Chart

<sup>12</sup> Hamilton and Flavin correct the official statistics of the U.S. public debt and the surplus from 1960 to 1984, to obtain a measure of the market value of the real public debt and of the real surplus inclusive of seigniorage revenues. The authors argue that the liquidation of public assets, with the exception of gold reserves, to reduce public debt or to finance interest expenditure is not a credible course of action. Hence, they compute the value of net public debt by subtracting from public debt only the market value of gold reserves. Accordingly, they adjust the figures for the surplus to take into account only the real yield on the public stock of gold. Wilcox (1989) provides data for the real rate of return on the net public debt as defined by Hamilton and Flavin.



2 illustrates the behaviour of the primary gap. Both indicators show a high volatility within sample and the possible existence of a sustainability problem starting from 1981.



Hamilton and Flavin (1986) perform the Flood and Garber's test and the Dickey and Fuller (1979)'s test for unit roots. The Flood and Garber's test allows them to reject the hypothesis that (2b) is not true. The authors find also values of the Dickey-Fuller's statistics of respectively -2.82 and -2.92 for the debt and the surplus, both significant at the 10% probability level, but not at the 5% level. They interpret this result as supporting the sustainability hypothesis.

In a subsequent work, Wilcox (1989) constructs the series of the discounted debt and surplus, so that (2) can approximate the ex ante evaluation of agents at time 0. The author rewrites equation (2a-b) in present values, and tests for unit roots in the discounted debt finding results of un-sustainability.

Wilcox argues that the unsustainable course of fiscal policy was the result of the change in regime brought in by the Reagan administration, and that this interpretation is supported by the existence of a structural break in the AR representation of the surplus in the year 1974.

The validity of any result based on unit roots tests, is, however questionable in presence of a structural break<sup>13</sup>. Hence, Hamilton and Flavin's and Wilcox' results should be considered with this proviso.

In order to implement our proposed testing technique, we need to find a stationary representation for the surplus. Our results from the augmented Dickey and Fuller's test, Phillips' test and Phillips & Perron's test are reported in table (1). They show that stationarity is surely achieved only for the first differences of the surplus. Hence, we adopt an AR representation in the first differences of the surplus. We use Hannan and Quinn's criterion to determine the order of the lag polynomial. This yields a lag-length of 4.

<sup>13</sup> See Perron (1989).

TABLE 1  
Unit Roots Tests for the Surplus

|                   | TEST Statistic |        |        | Significance Level |        |
|-------------------|----------------|--------|--------|--------------------|--------|
|                   | 1 lag          | 2 lags | 3 lags | 5%                 | 10%    |
| Z@^               | -12.83         | -12.30 | -10.84 | -12.50             | -10.20 |
| Zt@^              | -2.57          | -2.52  | -2.37  | -3.00              | -2.63  |
| ADF               | -2.87          | -2.55  | -2.27  | -3.00              | -2.63  |
| I DIFFERENCES     |                |        |        |                    |        |
| Z@^               | -23.89         | -21.57 | -18.56 | -12.50             | -10.20 |
| Zt@^              | -4.75          | -4.75  | -4.86  | -3.00              | -2.63  |
| ADF               | -4.11          | -3.91  | -5.41  | -3.00              | -2.63  |
| DISCOUNTED VALUES |                |        |        |                    |        |
| Z@^               | -15.59         | -14.59 | -12.90 | -12.50             | -10.20 |
| Zt@^              | -3.04          | -2.96  | -2.82  | -3.00              | -2.63  |
| ADF               | -3.25          | -2.88  | -3.48  | -3.00              | -2.63  |
| I DIFFERENCES     |                |        |        |                    |        |
| Z@^               | -25.01         | -22.37 | -19.44 | -12.50             | -10.20 |
| Zt@^              | -5.09          | -5.15  | -5.39  | -3.00              | -2.63  |
| ADF               | -4.37          | -3.89  | -6.41  | -3.00              | -2.63  |
| RATIOS TO GDP     |                |        |        |                    |        |
| Z@^               | -13.64         | -12.88 | -11.34 | -12.50             | -10.20 |
| Zt@^              | -2.75          | -2.68  | -2.53  | -3.00              | -2.63  |
| ADF               | -2.97          | -2.46  | -1.93  | -3.00              | -2.63  |
| I DIFFERENCES     |                |        |        |                    |        |
| Z@^               | -24.00         | -21.33 | -18.20 | -12.50             | -10.20 |
| Zt@^              | -4.81          | -4.83  | -5.00  | -3.00              | -2.63  |
| ADF               | -4.33          | -4.03  | -5.13  | -3.00              | -2.63  |

Z@^ and Zt@^ are Phillips & Perron (1986) tests on first lag parameters and on its t-value, ADF is the augmented Dickey & Fuller test, critical values are from Fuller 1976, and are for a sample size of 25.

Results from the IV estimation of equation (7) and from the unconstrained OLS estimates of equations (5) and (6) are given in tables (2) and (3). The goodness of fit is satisfactory and diagnostic checks do not reveal the presence of mis-specification. The Wald test is equal to 6.5, which is not significant at the usual levels. The hypothesis of an un-sustainable course of fiscal policy is, thus, rejected by the data.

TABLE 2  
Instrumental Variables estimation of the real discount factor  
(ratios to GDP)

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|                                          |                                       |                              |                              |                              |
|------------------------------------------|---------------------------------------|------------------------------|------------------------------|------------------------------|
| INSTRUMENTAL VARIABLES EQUATION          |                                       |                              |                              |                              |
| $D(b_t + s_t) =$                         | $-1.13 D(s_{t-1})$<br>(0.17)          | $-0.72 D(s_{t-2})$<br>(0.18) | $-0.30 D(s_{t-3})$<br>(0.16) | $-0.33 D(s_{t-4})$<br>(0.21) |
| $R^2 = 0.78, D.W. = 0.84, Q(10) = 27.56$ |                                       |                              |                              |                              |
| EQUATION (7)                             |                                       |                              |                              |                              |
| $D(b_t) =$                               | $1.03 D(b_{t-1} + s_{t-1})$<br>(0.27) |                              |                              |                              |
| $R^2 = 0.67, D.W. = 2.48, Q(10) = 5.91$  |                                       |                              |                              |                              |

D indicates differencing;  
standard error of estimates from Newey-West consistent VCV matrix are shown in brackets.

**TABLE 3**  
Unconstrained OLS estimation of equations (5-6)  
(ratios to GDP)

|                                                                                   |  |            |  |  |
|-----------------------------------------------------------------------------------|--|------------|--|--|
| EQUATION (5)                                                                      |  |            |  |  |
| $D(s_t) = -0.29 D(s_{t-1}) - 0.61 D(s_{t-2}) - 0.35 D(s_{t-3}) - 0.73 D(s_{t-4})$ |  |            |  |  |
| (0.11) (0.18) (0.14) (0.20)                                                       |  |            |  |  |
| $R^2 = 0.43, D.W. = 1.96, Q(10) = 8.10, L.M.(1) = 0.001, ARCH(1) = 2.82$          |  |            |  |  |
| EQUATION (6)                                                                      |  |            |  |  |
| $D(b_t) = -0.83 D(s_{t-1}) - 0.11 D(s_{t-2}) + 0.05 D(s_{t-3}) + 0.40 D(s_{t-4})$ |  |            |  |  |
| (0.22) (0.30) (0.14) (0.18)                                                       |  |            |  |  |
| $R^2 = 0.46, D.W. = 1.56, Q(10) = 10.63, L.M.(1) = 1.54, ARCH(1) = 0.79$          |  |            |  |  |
| WEST'S TEST = 6.46,                                                               |  | d.o.f. = 4 |  |  |

D indicates differencing;  
standard error of estimates from Newey-West consistent VCV matrix are shown in brackets.

Table (4) presents the results obtained from the estimation of (5-6), using both non linear SURE and 3SLS methods. Hausman's specification tests are equal, respectively, to 0.005 for the SURE and to 0.66 for the 3SLS estimator. These results strongly confirm the hypothesis of a sustainable course of fiscal policy in the US in the years 1960-1984.

**TABLE 4**  
Constrained SURE and 3SLS estimates of equations (5-6)  
(ratios to GDP)

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|                        |                                                        |                 |                 |                 |                |
|------------------------|--------------------------------------------------------|-----------------|-----------------|-----------------|----------------|
| SURE ESTIMATES         |                                                        |                 |                 |                 |                |
| Parameters             | a1                                                     | a2              | a3              | a4              | b1             |
|                        | -0.48<br>(0.17)                                        | -0.72<br>(0.19) | -0.58<br>(0.16) | -0.86<br>(0.13) | 1.04<br>(0.18) |
| EQUATION (5)           | $R^2 = 0.48, D.W. = 1.75, S.S.R. = 0.60 \cdot 10^{-3}$ |                 |                 |                 |                |
| EQUATION (6)           | $R^2 = 0.38, D.W. = 1.17, S.S.R. = 0.15 \cdot 10^{-2}$ |                 |                 |                 |                |
| HAUSMAN'S TEST = 0.005 |                                                        |                 |                 |                 |                |

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|                       |                                                        |                 |                 |                 |                |
|-----------------------|--------------------------------------------------------|-----------------|-----------------|-----------------|----------------|
| 3SLS ESTIMATES        |                                                        |                 |                 |                 |                |
| Parameters            | a1                                                     | a2              | a3              | a4              | b1             |
|                       | -0.53<br>(0.17)                                        | -0.70<br>(0.18) | -0.53<br>(0.15) | -0.84<br>(0.13) | 1.03<br>(0.20) |
| EQUATION (7)          | $R^2 = 0.48, D.W. = 1.65, S.S.R. = 0.61 \cdot 10^{-3}$ |                 |                 |                 |                |
| EQUATION (8)          | $R^2 = 0.36, D.W. = 1.15, S.S.R. = 0.16 \cdot 10^{-2}$ |                 |                 |                 |                |
| HAUSMAN'S TEST = 0.66 |                                                        |                 |                 |                 |                |

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standard error of estimates are shown in brackets.

All our testing results are in clear contrast with findings from indicators that, from 1981 onwards, show the possible existence of an unsustainable course of the U.S. fiscal policy. Thus, we test for a structural break to have occurred either in 1974, or in 1981<sup>14</sup>.

Table (5) gives the results from Chow tests for structural breaks in the

<sup>14</sup> Wilcox finds evidence of a structural break in his AR representation of the surplus in the year 1974. In 1981 begins a series of high negative primary gap and primary surplus, lasting to the end of the sample.



surplus generating process when specified in first differences. In both cases, the hypothesis is strongly rejected by data. There appear to be, thus, no sustainability problem for the US, and indicators are merely signalling the occurrence of a transitory period of high deficits. Such a short term phenomenon does not have any substantial implication for the soundness and consistency of longer term fiscal policy.

TABLE 5  
CHOW Tests for the surplus

| DIFFERENCES: |                  |
|--------------|------------------|
| 1974 split   | CHOW test = 0.66 |
| 1980 split   | CHOW test = 1.25 |

The distribution of both statistics is an  $F(4,12)$ .

## 6. Concluding remarks

The recent evolution of public debt in OECD countries requires some form of monitoring. Our suggested approach is as follows. The consistency of fiscal plans with government solvency should be tested over the relevant sample period. Direct tests of the hypothesis should be used for the purpose. Fiscal indicators derived from the present value budget constraints should also be calculated. Their interpretation, however, must be made contingent on results by tests, that is, according to whether or not there is a genuine sustainability problem.

For example, our results for the US data 1960-1984 reinforce the earlier finding of sustainability obtained by Hamilton and Flavin. According to the tests performed, the conduct of fiscal policy within sample is

perfectly consistent with government solvency. On the other hand, indicators show the need for some fiscal adjustment, especially towards the end of the period.

When indicators and tests give conflicting results, the stability of the AR representation of the surplus should be checked in order to establish whether indicators are merely responding to contingent factors or are detecting the existence of long term sustainability problems. In the case considered here, the indicators fail to signal the existence of a structural break in the AR representation of the surplus. Deficit increases in the US were thus a transitory phenomenon to be eventually reversed. Further research aimed at better integrating the formulation of indicators of sustainability with direct testing should prove useful for policy evaluation and design.

## References

- (1) Attanasio Orazio, Giancarlo Marini (1988) "Sulla sostenibilità del debito pubblico: alcune verifiche empiriche", CNR working paper.
- (2) Blanchard Olivier J. (1990) "Suggestions for a New Set of Fiscal Indicators", OECD working paper n.79.
- (3) Buiter Willem H. (1985) "A Guide to Public Sector Debt and Deficits" *Economic Policy*, vol.1, n.1 p.14-79.
- (4) Buiter Willem H. (1987) "The Current Global Economic Situation, Outlook and Policy Options, with Special Emphasis on Fiscal Policy Issues", C.E.P.R., discussion paper n.210.
- (5) Casella Alessandra (1989) "Testing for Rational Bubbles with Exogenous or Endogenous Fundamentals", *Journal of Monetary Economics*, vol.24, p.109-22.
- (6) Chouraqui Jean-Claude, Robert P. Hagemann and Nicola Sartor (1990) "Indicators of Fiscal Policy: a Reassessment", OECD working paper n.78, April.
- (7) Diba Behzad T. (1989) "Bubbles and Stock Price Volatility", Philadelphia/Research, working paper 89-19.
- (8) Dickey David A., Wayne A. Fuller (1979) "Distribution of the Estimators for Autoregressive Time Series with a Unit Root", *Journal of American Statistical Association*, vol.74, p. 427-31.
- (9) Flood Robert P., Peter M. Garber (1980) "Market Fundamentals Versus Price Level Bubbles: the First Tests", *Journal of Political Economy*, vol.88, p.745-70.
- (11) Fuller Wayne A. (1976) *Introduction to Statistical Time Series*, Wiley & Sons., New York.
- (12) Gramlich Edward M. (1990) "Fiscal Indicators", OECD working paper n.80.
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- (15) Hansen Lars P., Thomas J. Sargent (1981) "Formulating and Estimating Dynamic Linear Rational Expectations Models", in Lucas Robert E., Thomas J. Sargent (ed.), *Rational Expectations and Econometric Practice*, University of Minneapolis Press, Minneapolis.
- (16) Hausman Jerry A. (1978) "Specifications Tests in Econometrics", *Econometrica*, vol.46, p.1251-71.
- (17) Miller Marcus (1983) "Inflation Adjusting the Public Sector Financial Deficit", in Kay J. (ed.), *The 1982 Budget*, Basil Blackwell, London.
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- (22) Perron Pierre (1989) "Testing for a Unit Root in a Time Series with a Changing Mean", Princeton University E.R.P., research memorandum n.347.
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- (24) Schwert William G. (1989) "Tests for Unit Roots: A Monte Carlo Investigation", *Journal of Business and Economic Statistics*, vol.7, p.147-59.
- (25) West Kenneth D. (1987) "A Specification Test for Speculative Bubbles", *Quarterly Journal of Economics*, vol. 102, p.553-80.
- (26) Wilcox David W. (1989) "The Sustainability of Government Deficits: Implications of the Present-Value Borrowing Constraint", *Journal of Money, Credit and Banking*, vol. 21, p.291-306.

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