Debt Sustainability in the European Monetary Union: Theory and empirical evidence for selected countries

Alfred Greiner*, Uwe Koeller*, and Willi Semmler*†

Abstract

This paper studies the sustainability of fiscal policy for selected Euro-area countries. We focus on those countries that either have a high debt to GDP ratio (Italy) or have recently violated the Maastricht treaty by permitting more than three percent of the deficit to GDP ratio (France, Germany and Portugal). For undertaking such a study we apply and extend an approach developed by Bohn (1998) who proposes to study whether the intertemporal budget constraint of the government holds by modelling the public debt to GDP ratio as a mean-reverting process which is free from arbitrary discount rates that other approaches need to assume. By controlling for the impact of other variables on this mean-reverting process we can show that for the above mentioned countries fiscal policy is sustainable in the long, although the three percent rule of the Maastricht treaty might temporarily be violated. We also compare our results from the Euro-area countries to results obtained for the US fiscal policy.

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*Center for Empirical Macroeconomics, Bielefeld University, P.O. Box 100131, 33501 Bielefeld, Germany

†New School University, 65 Fifth Avenue, New York, NY 10003, USA

1 Introduction

The issue of public debt has become a primary interest of both economists and politicians since the 1990s in the Euro-area. Most of the OECD countries have revealed a chronic government deficit since the middle of the 1970s which has led to an increase in the debt to GDP ratio. Looking at time series data the major cause of the increase of the public debt in the 1970s was related to the two oil crises. In addition, the involvement of the governments of the EU member states in preserving and rebuilding of the welfare state in the Euro-area countries caused a rise of the public deficit and debt until the middle of the 1990s[1] but since then the efforts to reduce the public debt in preparation of the start of the European Monetary Union 1999 has led to declining public deficits. Only recently, in the recession 2001-2003, has the deficit increased again for some countries, in particular Germany and France.

In the academic debate on the deficit and debt of the Euro-area countries it has been argued that fiscal policy has been threatened to become unsustainable and that fiscal policy may neither be an instrument nor effective in stabilizing the macroeconomy any longer. This paper is concerned with formal econometric procedures that allow one to test for the sustainability of fiscal policy. What we are thus concerned with in this paper is not the short run violation of the stability and Growth pact of the European Monetary Union (EMU), but rather the long-run sustainability of fiscal policy of the member countries.

From the theoretical point of view the question of how large a private agent's debt can become is usually answered as follows. Private households are subject to the borrowing constraint which means that, given no initial debt, the expected present value of expenditures (exclusive of interest payments) should not exceed the expected present value of receipts, known as the no-Ponzi game condition. This condition implies that a private household cannot continually borrow and pay the interest by borrowing more.

[1] In Germany, it was in particular the unification of East and West Germany that has given rise to a debt to GDP ratio from about 44 percent in 1990 to roughly 58 percent in 1995.

There are limits of borrowing capacity of economic agents which are usually defined by the intertemporal budget constraints of the agents.[2]

For government debt this question has somewhat been left unsettled from the theoretical point of view. If a government could borrow and pay the interest by borrowing more any fiscal policy would be sustainable and in some suggested models this is indeed possible. [3] However, that possibility is not given any longer when the economy is dynamically efficient[4]. Then the government faces a present-value borrowing constraint stating that the current value of public debt must equal the discounted sum of future surpluses exclusive of interest payments.[5] Bohn (1995) has proved that in an exchange economy with infinitely lived agents the government must always satisfy the no-Ponzi game condition. In a series of papers Bohn (1991, 1995, 1998) not only presents a theoretical advancement of studying sustainability of public debt but also provides a new econometric approach to estimate sustainability of public debt.

Empirical studies which help to clarify whether governments follow the intertemporal budget constraint or not are indeed desirable. For the US there exist numerous studies starting with the paper by Hamilton and Flavin (1986). In this paper they propose a framework for analyzing whether governments can run a Ponzi scheme or not and apply the test to US time series data. They find sustainability of fiscal policy in the US. Other papers followed which also have investigated this issue for the US and other countries, but partly reached different conclusions (see e.g. Kremers, 1988, Wilcox, 1989, or Trehan and

[2]A model for sustainability of private debt is developed and studied in Grüne, Semmler and Sieveking (2003).

[3]In overlapping generations models, for example, which are dynamically inefficient a government can borrow in order to pay interest on outstanding debt (see Diamond, 1965), i.e. it may run a Ponzi scheme.

[4]For an empirical study analyzing whether the US economy is dynamically efficient, see Abel et al. (1989).

[5]McCallum (1984) has studied a perfect foresight version of the competitive equilibrium model of Sidrauski (1967) and proved that permanent primary deficits are not possible if the deficit is defined exclusive of interest payments.

Walsh, 1991 and Greiner and Semmler, 1999). However, these tests have been criticized by Bohn (1995, 1998) because they make assumptions about future states of nature that are difficult to estimate from a single set of observed time series data. In a recent paper Bohn (1998) proposes a new test that is not open to this criticism. In this paper we extend the approach by Bohn and apply it to some Euro-area countries.

The remainder is organized as follows. Section 2 elaborates on some theoretical considerations concerning the intertemporal budget constraint and provides a brief survey of the literature. Section 3 presents our estimation results and section 4 concludes the paper.

2 Some theoretical considerations

The accounting identity describing the accumulation of public debt in continuous time is given by:

$$\dot{B}(t) = B(t)r(t) - S(t), \tag{1}$$

where $B(t)$ stands for real public debt,[6] $r(t)$ is the real interest rate, and $S(t)$ is real government surplus exclusive of interest payments.

Solving equation (1) we get for the level of public debt at time t

$$B(t) = e^{\int_0^t r(\tau)d\tau}\left(B(0) - \int_0^t e^{-\int_0^\tau r(\mu)d\mu}S(\tau)d\tau\right), \tag{2}$$

with $B(0)$ public debt at time t. Multiplying both sides of (2) with $e^{-\int_0^t r(\tau)d\tau}$, to get the present value of the government debt at time t, yields

$$e^{-\int_0^t r(\tau)d\tau}B(t) + \int_0^t e^{-\int_0^\tau r(\mu)d\mu}S(\tau)d\tau = B(0). \tag{3}$$

[6]Strictly speaking, $B(t)$ should be real public net debt.

Assuming that the interest rate is constant[7] then (3) becomes

$$e^{-rt}B(t) + \int_0^t e^{-r\tau}S(\tau)d\tau = B(0). \tag{4}$$

If the first term in (4), $e^{-rt}B(t)$, goes to zero in the limit the current value of public debt equals the sum of the expected discounted future non-interest surpluses. Then we have

$$B(0) = E\int_0^t e^{-r\tau}S(\tau)d\tau, \tag{5}$$

with E denoting expectations. Equation (5) is the present-value borrowing constraint and we can refer to a fiscal policy which satisfies this constraint as a sustainable policy. It states that public debt at time zero must equal the expected value of future present-value surpluses. Equivalent to requiring that (5) must be fulfilled is that the following condition holds:

$$\lim_{t\to\infty} E\, e^{-rt}B(t) = 0. \tag{6}$$

That equation is usually referred to as the no-Ponzi game condition (see e.g. Blanchard and Fischer (1989), ch. 2).

In the economics literature numerous studies exist which explore whether (5) and (6) hold in real economies (see Hamilton and Flavin, 1986, Kremers, 1988, Wilcox, 1989, Trehan and Walsh, 1991, Greiner and Semmler, 1999). As remarked in the Introduction these tests, however, have been criticized by Bohn (1995, 1998). Bohn argues that they need strong assumptions because the transversality condition involves an expectation about states in the future that are difficult to obtain from a single set of time series data and because assumptions on the discount rate have to be made. As a consequence, the hypothesis that a given fiscal policy is sustainable has been rejected too easily.

Therefore, Bohn (1995, 1998) introduces a new sustainability test which analyzes whether a given time series of government debt is sustainable. The starting point of his

[7]In the following we make this assumption since it simplifies the analysis. In the Appendix we discuss our main result (Proposition 2) for a time-varying interest rate and a time-varying GDP growth rate.

new analysis is the observation that in a stochastic economy discounting future government spending and revenues by the interest rate on government bonds is not correct. Instead, the discount factor on future spending and revenues depends on the distributions of these variables across possible states of nature.

As an alternative test, Bohn proposes to test whether the primary deficit to GDP ratio is a positive linear function of the debt to GDP ratio. If this holds, a given fiscal policy is said to be sustainable. The reasoning behind this argument is that if a government raises the primary surplus, if public debt increases, it takes a corrective action which stabilize the debt ratio. This implies that the debt to GDP ratio displays mean-reversion and thus the ratio remains bounded. Before we undertake empirical tests we pursue some theoretical considerations about the relevance of this test for deterministic economies.

We assume a deterministic economy in continuous time in which the primary surplus of the government relative to GDP depends on the debt to GDP ratio and on a constant, i.e.

$$\frac{T(t) - G(t)}{Y(t)} = \alpha + \beta \left(\frac{B(t)}{Y(t)} \right), \tag{7}$$

with $T(t)$ tax revenue at time t, $G(t)$ public spending exclusive of interest payments at time t, $Y(t)$ GDP at time t, $B(t)$ public debt at time t and α, $\beta \in \mathbb{R}$ constants.[8] All variables are real variables.

Defining $b \equiv B/Y$ the public debt to GDP ratio evolves according to the following differential equation

$$\dot{b} = b \left(\frac{\dot{B}}{B} - \frac{\dot{Y}}{Y} \right) = b \left(r + \frac{G - T}{B} - \gamma \right), \tag{8}$$

with $r > 0$ the constant real interest rate and $\gamma > 0$ the constant growth rate of real GDP.

Using (7) the differential equation describing the evolution of the debt-GDP ratio can be rewritten as

$$\dot{b} = b \left(r - \gamma - \beta \right) - \alpha. \tag{9}$$

[8] In the following we leave aside the time argument t if no ambiguity arises.

Solving this differential equation we get the debt to GDP ratio b as a function of time which is given by

$$b(t) = \frac{\alpha}{(r-\beta-\gamma)} + e^{(r-\beta-\gamma)t}\, C_1, \tag{10}$$

where C_1 is a constant given by $C_1 = b(0) - \alpha/(r-\beta-\gamma)$, with $b(0) \equiv B(0)/Y(0)$ the debt-GDP ratio at time $t = 0$. We assume that $b(0)$ is strictly positive, i.e. $b(0) > 0$ holds. With the debt-GDP ratio given by (10) we can state our first result in proposition 1 defining conditions for the boundedness of the debt-GDP ratio.

Proposition 1 *For our economy the following turns out to be true.*
(i) $\beta > 0$ is a sufficient condition for the debt-GDP ratio to remain bounded if $r < \gamma$.
(ii) For $\beta > 0$ and $r > \gamma$ the debt-GDP ratio remains bounded if and only if $r - \gamma < \beta$.
(iii) For $\beta < 0$ a necessary and sufficient condition for the debt-GDP ratio to remain bounded is $r - \beta < \gamma$.

Proof: The proof follows from (10). $\beta > 0$ and $r < \gamma$ gives $\lim_{t\to\infty} e^{(r-\beta-\gamma)t} C_1 = 0$. If $\beta > 0$ and $r > \gamma$, $\lim_{t\to\infty} e^{(r-\beta-\gamma)t} C_1 = 0$ holds if and only if $r - \beta - \gamma < 0$. This proves (i) and (ii). If $\beta < 0$ the second term in (10) converges to zero if and only if $r - \beta - \gamma$ holds. This proves (iii). □

This proposition demonstrates that a linear increase in the primary surplus to GDP ratio as a result of an increase in the debt to GDP ratio, i.e. $\beta > 0$, is neither a necessary nor a sufficient condition for the debt to GDP ratio to remain bounded for our deterministic economy with a constant real interest rate and a constant growth rate of real GDP unless additional conditions hold. Provided that the GDP growth rate exceeds the interest rate a positive β is sufficient for the boundedness of the debt to GDP ratio. If the interest rate equals the marginal product of capital and if there are decreasing returns to capital the economy is dynamically inefficient if the growth rate of GDP exceeds the interest rate. If the interest rate is larger than the growth rate the economy is dynamically efficient and the debt-GDP ratio remains bounded if β exceeds the difference between the interest rate

and the GDP growth rate. If the latter inequality does not hold the debt-GDP ratio does not converge.

On the other hand, a negative β may imply a bounded debt to GDP ratio. A necessary and sufficient condition is that the growth rate of GDP must be sufficiently large, that is it must exceed the interest rate plus the absolute value of β. This implies that in a dynamically efficient economy, where $r > \gamma$ holds, a negative β is sufficient for the debt to GDP ratio to become unbounded.

Proposition 1 gives conditions which assure that the debt to GDP ratio remains bounded. However, the proper intertemporal budget constraint of the government requires that the discounted stream of government debt converges to zero. Therefore, we next study whether the intertemporal budget constraint of the government holds, which requires $\lim_{t\to\infty} e^{-r\,t} B(t) = 0$,[9] given our assumption that the primary deficit to GDP ratio is a linear function of the debt-GDP ratio as postulated in equation (7). Using that equation the differential equation describing the evolution of public debt can be written as

$$\dot{B}(t) = r\,B(t) + G(t) - T(t) = (r-\beta)\,B(t) - \alpha\,Y(t). \tag{11}$$

Solving this differential equation gives public debt as an explicit function of time. Thus, $B(t)$ is given by

$$B(t) = \left(\frac{\alpha}{r-\gamma-\beta}\right) Y(0)\,e^{\gamma\,t} + e^{(r-\beta)\,t}\,C_2, \tag{12}$$

with $B(0) > 0$ debt at time $t = 0$ which is assumed to be strictly positive and with C_2 a constant given by $C_2 = B(0) - Y(0)\,\alpha/(r-\gamma-\beta)$. Given this expression we can state conditions which must be fulfilled so that the intertemporal budget constraint of the government can hold.

[9]Here, it should be noted that we exclude a strictly negative limit implying that the government would accumulate wealth since this is of less relevance for real economies.

Proposition 2 *For our model economy the following turns out to hold true.*
(i) For $\alpha \geq 0$, *the intertemporal budget constraint of the government holds if* $\beta > 0$.
(ii) For $\alpha < 0$, *the intertemporal budget constraint of the government is fulfilled for* $\beta > 0$ *and* $r > \gamma$.
(iii) For $\beta < 0$ *the intertemporal budget constraint of the government is not fulfilled except for* $B(0) = Y(0)\,\alpha/(r - \gamma - \beta)$ *and* $r > \gamma$.

Proof: To prove this proposition we write the expression $e^{-r\,t}B(t)$ as

$$e^{-r\,t}B(t) = \left(\frac{\alpha}{r - \gamma - \beta}\right) Y(0)\, e^{(\gamma - r)\,t} + e^{-\beta\,t}\, C_2$$

For $\beta > 0$ the term $e^{-\beta\,t}\,C_2$ converges to zero for $t \to \infty$. The first term of $e^{-r\,t}B(t)$ also converges to zero for $t \to \infty$ if $r > \gamma$ holds. If $r < \gamma$ holds the first term converges to $-\infty$ for $t \to \infty$ and $\alpha > 0$. This case, however, is excluded by assumption. Thus, (i) is proven. For $\alpha < 0$ and $\beta > 0$ the first term of $e^{-r\,t}B(t)$ converges to zero for $t \to \infty$ if $r > \gamma$ holds. This proves (ii). For the sake of completeness we note that $r > \gamma$ implies $e^{-r\,t}B(t) \to \pm\infty$ depending on the sign of $r - \gamma - \beta$. Finally, for $\beta < 0$ the expression $e^{-r\,t}B(t)$ converges to zero if $C_2 = 0$, which is equivalent to $B(0) = Y(0)\,\alpha/(r - \gamma - \beta)$, and if $r > \gamma$ hold. If this does not hold $e^{-r\,t}B(t)$ diverges either to $+\infty$ or to $-\infty$. □

Proposition 2 shows that the discounted value of public debt converges to zero if the surplus to GDP ratio positively reacts to increases in the debt ratio, i.e. if $\beta > 0$ holds, provided that there is no autonomous decrease in the primary surplus ratio, i.e. for $\alpha \geq 0$. This implies that the level of the primary surplus must not decline with an increase in GDP. If the reverse holds, i.e. if the level of the primary surplus declines with a rise in GDP ($\alpha < 0$), $\beta > 0$ guarantees that the intertemporal budget constraint of the government holds if the interest rate exceeds the growth rate of GDP, i.e. for dynamically efficient economies. Thus, as long as economies are dynamically efficient, $\beta > 0$ guarantees that the discounted public debt converges to zero and, thus, is a sufficient condition for sustainabilty of a given fiscal policy.

If the reverse holds, i.e. in dynamically inefficient economies where $r < \gamma$ holds, the present value of government debt explodes and the intertemporal budget constraint is not fulfilled. However, it must be pointed out that in such economies the intertemporal budget constraint is irrelevant. This holds because in dynamically inefficient economies the government can issue debt and roll it over indefinitely and cover interest payments by new debt issues, i.e. the government can indeed play a Ponzi game. Finally, the intertemporal budget constraint is not fulfilled if the government reduces its primary surplus as the debt ratio rises, i.e. for $\beta < 0$, except for the hairline case $B(0) = Y(0)\,\alpha/(r - \gamma - \beta)$.[10]

These theoretical considerations demonstrate that in a deterministic economy an increase in the primary surplus to GDP ratio as a consequence of a rise in the debt to GDP ratio guarantees that the intertemporal budget constraint of the government is fulfilled in dynamically efficient economies. So, looking at the relationship between the primary surplus ratio and the debt ratio allows to draw conclusions about the sustainability of a given fiscal policy so that empirically estimating equation (7) seems to be a powerful test. Yet, we might also have to control for other variables impacting the dynamics of equation (7).

In the next section, we perform this test for some countries in the EMU which have been characterized by high deficits.

3 Empirical Analysis

The previous section has highlighted two alternative estimation strategies to test for sustainability of fiscal policy. We here pursue the test based on the mean-reversion of the debt-income ratio where it is proposed to study how the primary surplus reacts to the debt-GDP ratio in order to test whether a given fiscal policy is sustainable. The main

[10]It should be recalled that we exclude the case where $e^{-r\,t}B(t)$ becomes strictly negative.

idea is to estimate the following equation

$$s_t = \beta b_t + \alpha^\top \mathbf{Z_t} + \epsilon_t \tag{13}$$

where s_t and b_t is the primary surplus and debt ratio respectively, $\mathbf{Z_t}$ is a vector which consists of the number 1 and of other factors related to the primary surplus and ϵ_t is an error term which is i.i.d.[11]

As concerns the other variables contained in $\mathbf{Z_t}$, which are assumed to affect the primary surplus, we include the net interest payments on public debt relative to GDP ($Interest$) and a variable reflecting the business cycle ($YVAR$). YVAR is calculated by applying the HP-Filter twice on the GDP-Series.[12] Further, in the first two estimations the social surplus ratio ($Social$) is subtracted from the primary surplus ratio and is considered as exogenous in order to catch possible effects of transfers between the social insurance system and the government.[13] In the third equation to be estimated the social surplus ratio is included in the primary surplus ratio. The last equation, finally, is equation (7) which only contains a constant and the debt ratio as explanatory variables. We do not expect this equation to yield good estimation results but we nevertheless estimate it because this equation was used to derive propositions 1 and 2.

In addition, we decided that it is more reasonable to include the lagged debt ratio b_{t-1} instead of the instantaneous b_t, although theory says that the response of the surplus on higher debt should be immediate. We do this, because interest payments on debt and repayment of the debt occurs at later periods.[14]

[11] See Bohn (1998: 951).

[12] Arby (2001) suggested to first extract the long-run trend from the original series and then to filter out the cyclical component from the rest.

[13] $Social_t$ is computed by subtracting Social Benefits Paid By Government from the Social Security Contributions Received By Government .

[14] We also made the estimations with b_t instead of b_{t-1}. The result are basically the same but the standard errors of the coefficients are different. Details are available on request.

Summarizing our discussion the equations to be estimated are as follows:

$$s_t = \alpha_0 + \beta b_{t-1} + \alpha_1 Social_t + \alpha_2 Interest_t + \alpha_3 YVAR_t + \epsilon_t \quad (14)$$

$$s_t = \alpha_0 + \beta b_{t-1} + \alpha_2 Interest_t + \alpha_3 YVAR_t + \epsilon_t \quad (15)$$

$$s_t^{soc} = \alpha_0 + \beta b_{t-1} + \alpha_2 Interest_t + \alpha_3 YVAR_t + \epsilon_t \quad (16)$$

$$s_t^{soc} = \alpha_0 + \beta b_{t-1} + \epsilon_t \quad (17)$$

where s_t is the primary surplus ratio exclusive of the social surplus and s_t^{soc} denotes the primary surplus ratio including the social surplus.

Estimating (14)-(17) with ordinary least squares (OLS) may give biased standard errors and t-statistics because of possible heteroskedasticity and autocorrelation in the residuals. In spite of this problem we use OLS estimation but calculate heteroskedasticity- and autocorrelation consistent t-statistics to get robust estimates (see White, 1980, and Newey and West, 1987).

The estimations are undertaken for five countries: Germany, France, Italy, Portugal and the United States. The chosen Euro-area countries suffered from high debt and deficits, having violated the Maastricht criteria recently, and so they motivate our choice for the tests whether their fiscal policies can be regarded as sustainable.

3.1 France

Figure 1 indicates that the debt ratio has been growing most of the time and increased very fast at the beginning of the 1990s. Until the mid-nineties France experienced deficits (net of the social surplus) which has led to a further deterioration of the high debt ratio.

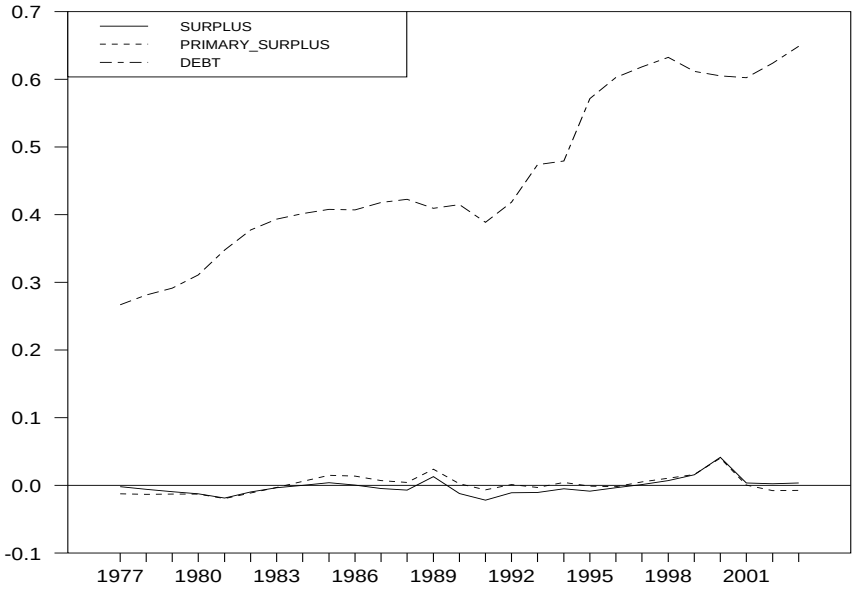

Figure 1: Primary surplus- and debt-GDP ratio for France (1977-2003)

The primary deficit displays a remarkably different trend. Relative low deficits, and in some cases primary surpluses, generated only a moderate growth of the debt ratio. The recession in the early nineties caused higher deficits and reduced social surpluses created higher debt ratios. In face of the Maastricht criteria France strengthened its fiscal discipline and reduced the debt ratio. Since the last recession, at the beginning of 2001, the fiscal situation worsened and the debt ratio has been growing again.

Going back to the relationship between the primary surplus and debt ratio the next figure shows a weak negative relationship between the surplus and debt. As figure 2 shows after the debt ratio reached the 50% limit apparently corrective measures were taken and a positive slope can be observed.

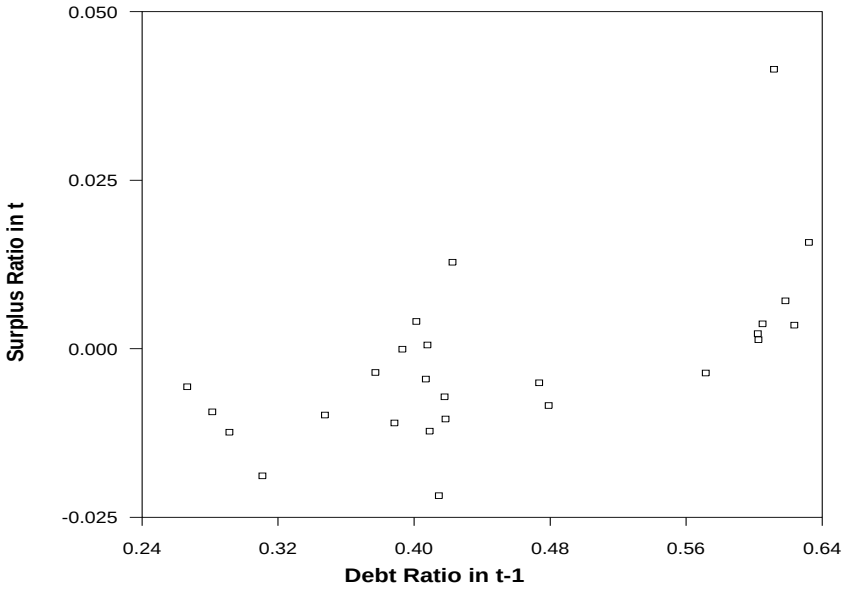

Figure 2: s_t vs. b_{t-1} for France (1977-2003)

Equation (14) is estimated for the entire sample period. We obtain the following result

	Coeff.	*Std. Error (t-stat.)*
constant	-0.012	0.019 (-0.597)
b_{t-1}	0.077	0.042 (1.812)
$Social_t$	-0.913	0.297 (-3.078)
Int_t	1.256	0.753 (1.667)
$YVAR_t$	-0.048	0.187 (-0.257)
R^2 / DW	0.749 / 1.063	

Table 1: Estimates for equation (14)

The parameter of interest β is positive and significant at the 10% level (t-statistic = 1.812), indicating that overall French fiscal policy has followed a sustainable path. As one can observe corrective measures were taken if an increase in the debt ratio of the last period was observed. The good fit of the model is displayed by a high R^2 of 0.749. The Durbin-Watson (DW) statistic is 1.063. The α_1 parameter shows a negative response of

high social surplus to debt. This might be interpreted that a high social surplus weakens the fiscal discipline and lowers the deficit. The positive sign of the α_2 parameter indicates the efforts of the government to run surpluses to pay the debt service.

The cyclical variable is insignificant at all usual levels which might be caused by the fact that the French business cycle was following the German business cycle because of the fixed European exchange rate system and because of the Bundesbank interest rate policy.

Furthermore we have estimated equation (15) as well as equations (16) and (17) where we replaced the primary surplus (s_t) by the primary surplus inclusive of the social surplus (s_t^{soc}). The results are presented in table 2

	Dependent variable: s_t		Dependent variable: s_t^{soc}		Dependent variable: s_t^{soc}	
	Coeff.	*Std. Error (t-stat.)*	*Coeff.*	*Std. Error (t-stat.)*	*Coeff.*	*Std. Error (t-stat.)*
constant	-0.061	0.009 (-7.655)	-0.007	0.007 (-0.997)	-0.009	0.005 (-1.523)
b_{t-1}	0.140	0.029 (4.830)	0.071	0.032 (2.206)	0.012	0.013 (0.928)
Int_t	0.993	0.686 (1.447)	1.281	0.751 (1.706)		
$YVAR_t$	-0.321	0.175 (-1.834)	-0.022	0.194 (-0.114)		
R^2	0.683		0.294		0.031	
DW	0.941		1.076		0.657	

Table 2: Estimates for equation (15), equation (16) and equation (17)

The estimate of β in equation (15) and in equation (16) is in both cases positive and significant at the 1% level. In both estimations the cyclical variable remains insignificant and the net interest variable becomes also insignificant at the 5% level. Further, a reduction in the R^2 value can be observed which leads to the conclusion that equation (14) fits the data best. The estimation of equation (17) yields the coefficients which have the same signs as in the other regressions. However, none of the coefficients is statistically significant.

Summarizing, one cannot reject the hypothesis of a mean reversion process for the French debt-GDP ratio. Using proposition 2, sustainability of fiscal policy also seems to

be given although the constant α_0 is negative. This holds because the interest rate in France has exceeded the growth rate of GDP, at least since the early eighties,[15] so that the intertemporal budget constraint is fulfilled according to (ii) in proposition 2. Thus, the hypothesis of an overall sustainable fiscal policy cannot be rejected for France. Next, we look at Germany.

3.2 Germany

As figure 3 shows at the beginning of the mid-seventies the German government was confronted with high debt ratios accompanied with permanent primary deficits. Furthermore, in figure 4 two episodes of a sharp rise in the growth rate of public debt can be observed followed by periods with budgetary discipline and lower increasing debt ratios. In the mid-seventies the debt ratio increases very rapidly, due to the oil shock, which also caused a recession with the rise of the unemployment rate. This fact is highlighted in figure 3 by the solid line for debt to GDP ratio and the dotted lines for the primary surplus. The second sharp increase of the debt ratio was caused by the German unification and began in the early nineties as the GDP growth rates slowed down.

[15]This holds for Germany, Italy and Portugal, too.

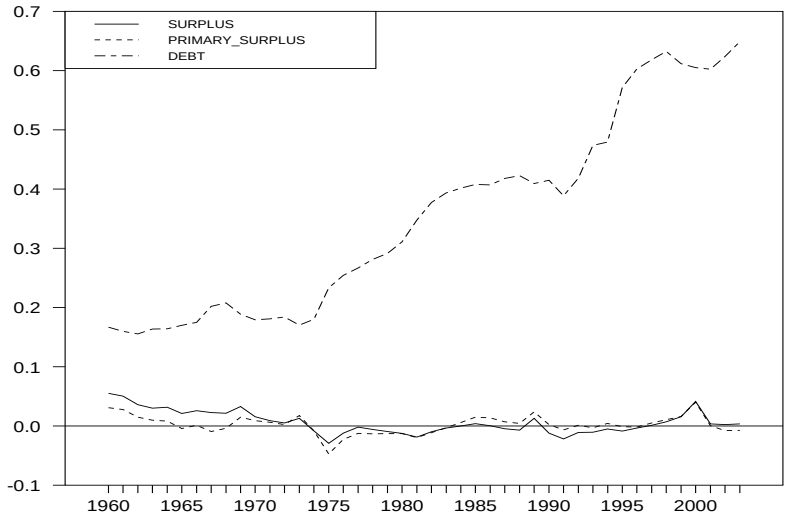

Figure 3: Primary surplus- and debt-GDP ratio for France (1977-2003)

If debt ratios smaller than 0.2 are disregarded a weak positive slope for the regression line can be realized. Yet, the entire data set clearly shows the phases of fiscal consolidation in the eighties and the consolidation efforts to join the EMU (cf. figure 3).

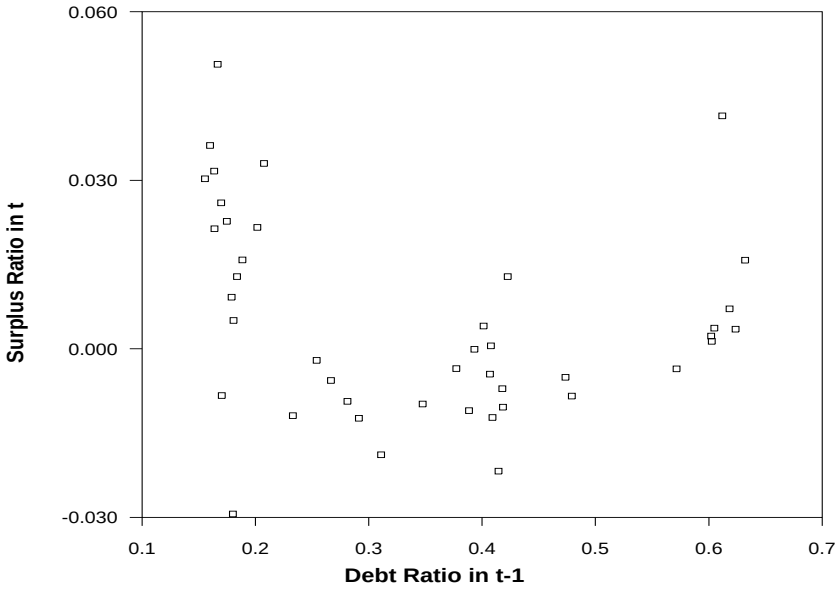

Figure 4: s_t vs. b_{t-1} for Germany (1960-2003)

Next, we explore if the test procedure agrees with our presumptions. For equation (14) we get the estimates

	Coeff.	*Std. Error (t-stat.)*
constant	-0.002	0.005 (-0.415)
b_{t-1}	0.148	0.043 (3.467)
$Social_t$	-0.068	0.255 (-0.266)
Int_t	2.552	0.670 (3.810)
$YVAR_t$	0.240	0.060 (3.967)
R^2 / DW	0.642 / 1.181	

Table 3: Estimates for equation (14)

The β coefficient of 0.148 is significant at all ratios and indicates a strong positive response of the primary surplus to a higher debt in the previous period. The same effect is observed for the variables net interest payment and business cycle and the coefficients are both highly significant. But a significantly positive effect of the social surplus on the primary surplus cannot be observed. The good fit of the data is reflected in the relatively high R^2 of 0.642 and a DW statistic of 1.181, although there still must be other variables involved to explain the remaining structure of the residuals. Finally, let us look at the other three regressions which are summarized in table 3.

	Dependent variable: s_t		Dependent variable: s_t^{soc}		Dependent variable: s_t^{soc}	
	Coeff.	*Std. Error*	*Coeff.*	*Std. Error*	*Coeff.*	*Std. Error*
constant	-0.001	0.005 (-0.270)	-0.011	0.007 (-1.720)	-0.005	0.006 (-0.806)
b_{t-1}	0.153	0.035 (4.411)	0.078	0.043 (1.840)	0.018	0.015 (1.192)
Int_t	2.676	0.446 (5.995)	0.851	0.529 (1.609)		
$YVAR_t$	0.241	0.059 (4.103)	0.219	0.070 (3.114)		
R^2	0.641		0.241		0.038	
DW	1.177		1.045		0.883	

Table 4: Estimates for equation (15), equation (16) and equation (17)

In the first test, with s_t as the dependent variable, all parameters, except the constant,

are highly significant and the sustainability coefficient β has a positive sign. The second test, with the s_t^{soc} as the dependent variable, shows a slightly different scenario. The β coefficient of 0.078 is only significant at the 10% level and the net interest payments and the constant term are insignificant. Looking at R^2 and the DW statistic we draw the conclusion that the first model fits better than the other two. As for France, the estimation of equation (17) does not produce statistically significant results. Nevertheless, the coefficients have the same signs as in the other estimations.

As for the case of France our estimations suggest that Germany follows a sustainable fiscal policy. In all estimations the primary surplus ratio increases with a rising debt ratio suggesting that the debt ratio displays mean reversion.

One can presume that German unification in 1990 generated a structural break at that period. Therefore, we have split the sample into two parts and estimated equation (14) for the two sub-samples. One period is from 1960-1989 and the other one from 1990-2003. For the first sub-sample the results of our model remain basically unchanged ($R^2 = 0.820$ and $DW = 0.979$) and the β-value increases to 0.378 (t-statistic = 5.448). The other parameters, except for the social surplus, show strong significance and the expected sign. In the second sub-sample almost all estimates are insignificant which is possibly due to the small data set. Nevertheless, the coefficient β with a value of 0.162 is significantly different from zero at the 10 % level (t-statistic = 1.833). Our presumption that the unification significantly influenced the fiscal policy of Germany seems to be supported by the test.

3.3 Italy

Since the mid-eighties, Italy has shown a fast growing debt ratio accompanied by a permanent primary deficit. Faced with the criteria for joining the EMU in 1999, fiscal policy changed its course and the Italian government has lowered the deficits and at the beginning of the nineties, surplus stopped the growth of public debt ratio. Although the debt

criteria could not be fulfilled at the start of the EMU, Italy joined the EMU in 1999. The trends of Italian fiscal policy are shown in figure 5.

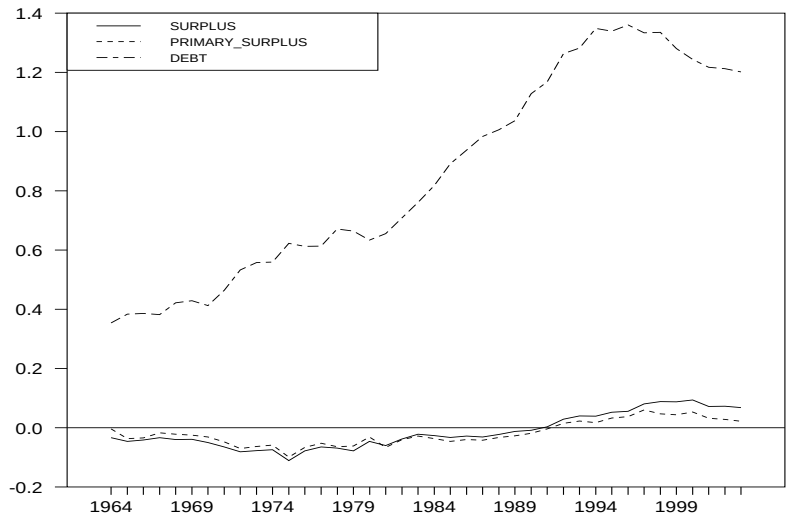

Figure 5: Primary surplus- and debt-GDP ratio for Italy (1964-2003)

An overall consolidation effort of the fiscal policy in response to higher debt ratios is suggested by figure 6 in which the primary surplus ratio is plotted against the debt ratio. Apparently the Italian government tried to increase the surplus ratio in order to stabilize the growing indebtedness.

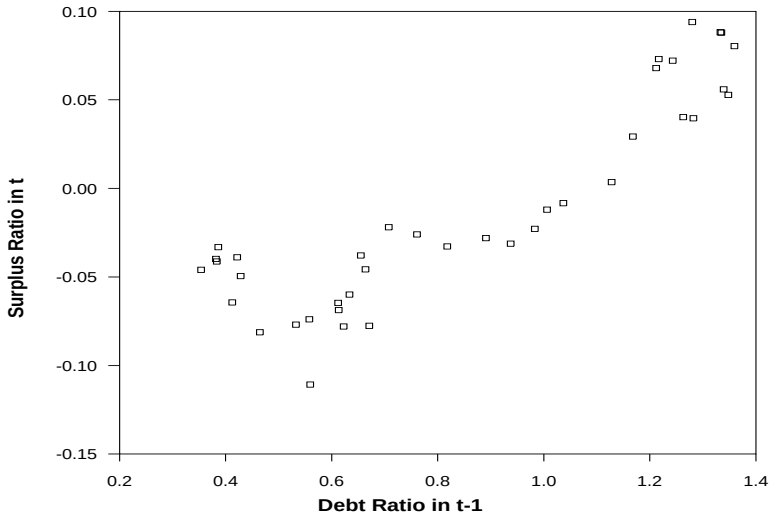

Figure 6: s_t vs. b_t for Italy (1964-2003)

This conclusion is also reached by the results of our test. The estimation of the equation (14) yields

	Coeff.	*Std. Error (t-stat.)*
constant	-0.122	0.013 (-9.461)
b_{t-1}	0.163	0.023 (6.956)
$Social_t$	-0.531	0.274 (-1.933)
Int_t	0.525	0.131 (4.000)
$YVAR_t$	0.128	0.024 (5.339)
R^2 / DW	0.911 / 1.071	

Table 5: Estimates for equation (14)

The response parameter β is 0.163 and significant at all levels (t-statistic = 6.956), meaning that the above stated conjecture of a sustainable fiscal policy holds in spite of the extraordinarily high initial debt ratio. The other estimates are all significantly different from zero although the social surplus effect is only small with a coefficient of 0.053. Finally, the R^2 reaches 0.911 and the DW-statistic is 1.071. The latter suggests that there might be still some structure in the residual which is not covered by our framework.

Next, we have estimated equations (15), (16) and (17). The results are shown below in table 6.

	Dependent variable: s_t		Dependent variable: s_t^{soc}		Dependent variable: s_t^{soc}	
	Coeff.	*Std. Error*	*Coeff.*	*Std. Error*	*Coeff.*	*Std. Error*
constant	-0.143	0.007 (-19.393)	-0.103	0.007 (-14.045)	-0.019	$6.445 \cdot 10^{-3}$ (-2.963)
b_{t-1}	0.199	0.011 (18.525)	0.131	0.010 (13.246)	$2.398 \cdot 10^{-6}$	$9.837 \cdot 10^{-7}$ (2.438)
Int_t	0.628	0.110 (5.714)	0.434	0.101 (4.290)		
$YVAR_t$	0.138	0.023 (5.938)	0.118	0.023 (5.195)		
R^2	0.906		0.812		0.004	
DW	0.997		1.109		0.163	

Table 6: Estimates for equation (15), equation (16) and equation (17)

Those estimates confirm our results above. The Italian fiscal policy points to sustainability in the long run in spite of the initial high debt-income ratio. Both β-coefficients of 0.199 and 0.131 in equations (15) and (16), respectively, are positive and significant suggesting that corrective measures in balancing the budget, or running a surplus, have been taken. This holds although the estimation of equation (17) yields a β-coefficient which is virtually zero. But again, this equation is characterized by an extremely small R^2 and DW-statistic.

3.4 Portugal

Another candidate for testing sustainability of fiscal policy is Portugal which has also been in the news for violating the Maastricht criteria. The situation in Portugal differs from Italy in the fact that Portugal's indebtedness is relatively small, but it primarily suffered from persistent deficits in the last years as shown in figure 7. The main difference to the other countries is that Portugal's net interest payments affects its budget in an extreme way, i.e. the primary surplus is nearly zero over most of the sample period but paying the debt service generates a public deficit.

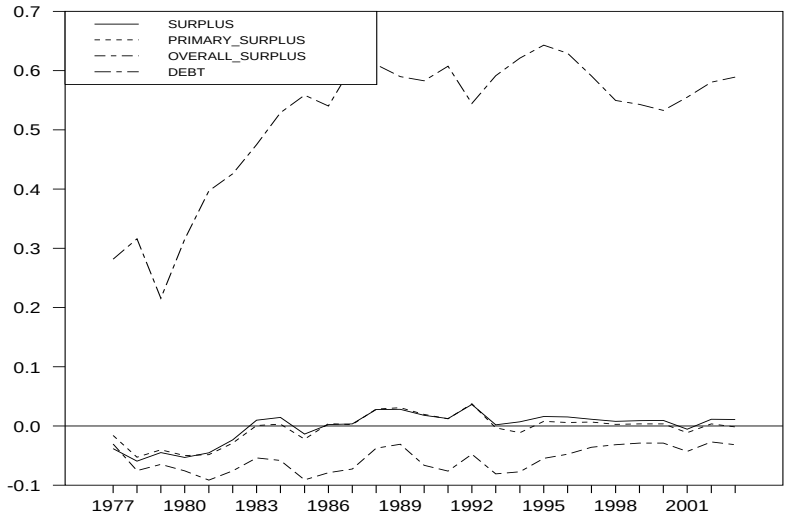

Figure 7: Primary surplus- and debt-GDP ratio for Portugal (1977-2003)

Despite the problem of the high net interest payments Portugal shows a positive relationship between primary surplus and debt ratios as can be observed from figure 8.

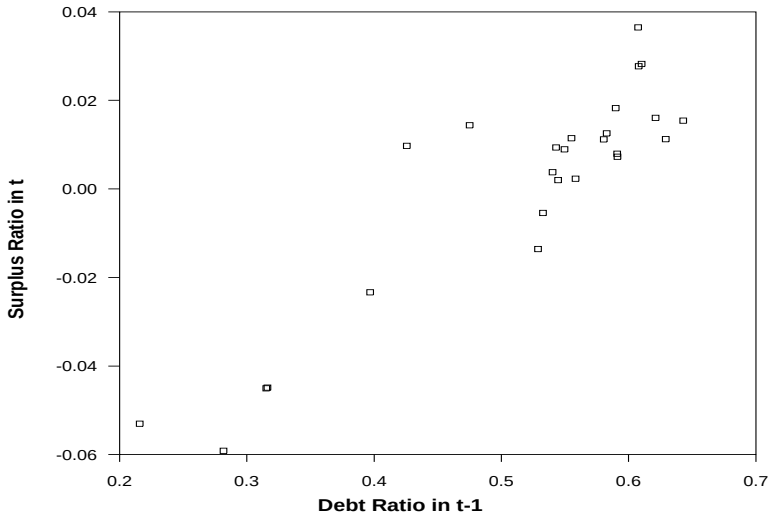

Figure 8: s_t vs. b_t for Portugal (1977-2003)

The estimation of equation (14) for Portugal gives the following results,

	Coeff.	*Std. Error (t-stat.)*
constant	-0.083	0.012 (-7.112)
b_{t-1}	0.164	0.025 (6.547)
$Social_t$	0.314	0.364 (0.863)
Int_t	-0.014	0.093 (-0.154)
$YVAR_t$	-0.051	0.014 (-3.691)
R^2 / DW	0.861 / 1.811	

Table 7: Estimates for equation (14)

The main parameter β with a value of 0.164 is positive and significant at all usual levels (t-statistic = 6.547). The same holds for the constant and the business cycle variable. Yet, the latter shows a negative sign which means if the economy is growing the surplus will be reduced. As in the case of France the business cycle upswing has also a negative effect on the surplus but in the case of France, it was not significantly different from zero. The remaining variables social surplus and interest payments do not have a significant effect on the primary surplus. The R^2 value of 0.861 and the DW-statistic of 1.812 indicate that the data is very well represented by equation (14). Estimating equation (15), equation (16) and equation (16) gives results as shown in table 8.

	Dependent variable: s_t		Dependent variable: s_t^{soc}		Dependent variable: s_t^{soc}	
	Coeff.	*Std. Error*	*Coeff.*	*Std. Error*	*Coeff.*	*Std. Error*
constant	-0.085	0.012 (-6.789)	-0.090	0.013 (-6.829)	-0.095	0.008 (-11.588)
b_{t-1}	0.161	0.022 (7.073)	0.150	0.022 (6.663)	0.176	0.017 (10.576)
Int_t	-0.054	0.087 (-0.466)	-0.181	0.098 (-1.848)		
$YVAR_t$	-0.043	0.018 (-1.938)	-0.015	0.017 (-0.880)		
R^2	0.858		0.780		0.749	
DW	1.833		1.697		1.466	

Table 8: Estimates for equation (15), equation (16) and equation (17)

The results in table 8 are not very surprising if one looks at figure 8. It can be explained by the small distance between the primary surplus series excluding the social surplus (s_t)

and including the social surplus (s_t^{soc}), that is by the almost balanced social budget. The parameters of interest in equations (15), equation (16) are both positive and significant and take the value 0.161 and 0.150, respectively (t-statistics = 7.393 and 6.663). Even equation (17) produces statistically significant results and acceptable values for R^2 and for the DW-statistic.

3.5 US

Finally we will look at the fiscal policy trend of the United States. Many authors have focused their attention on the sustainability of fiscal policy in the US. This issue is back in the news due to the actual deficit caused by the Iraq war and the tax cuts to stimulate the US economy. We first consider the graph giving the time series of US debt- and primary surplus ratios and the scatter plot of these two variables.

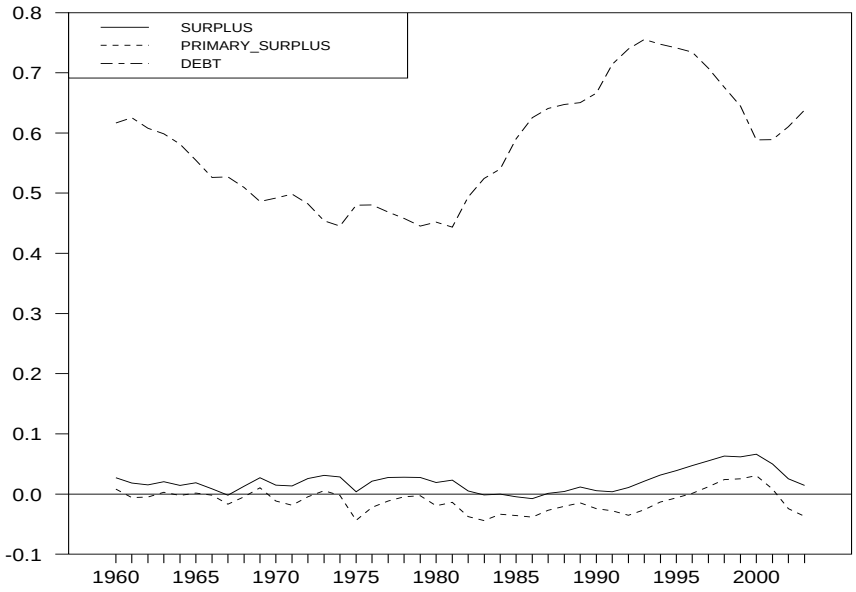

Figure 9: Primary surplus- and debt-GDP ratio for the U.S. (1960-2003)

The primary surplus ratio excluding the social surplus is almost always positive. Until the Reagan Administration took over in 1980 the debt ratio fell and began to grow until

the Democrats won the White House back in 1992.

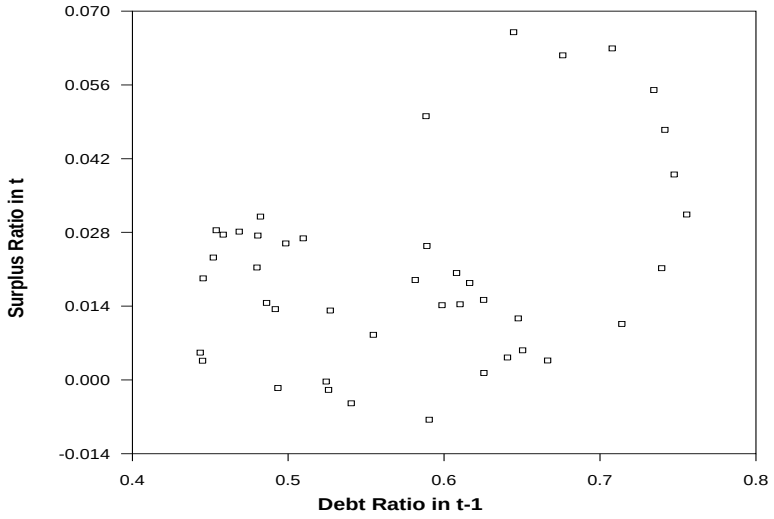

Figure 10: s_t vs. b_t for the U.S. (1960-2003)

Concerning the scatter plot a weak positive relationship can be observed even if the volatility around the imaginary regression line increases. This suggests that those outliers may cause problems with the residuals and are likely to show up in a poor DW-statistic and possibly a low R^2. For the first regression we get,

	Coeff.	*Std. Error (t-stat.)*
constant	-0.056	0.017 (-3.309)
b_{t-1}	0.165	0.035 (4.683)
$Social_t$	-0.600	0.266 (2.259)
Int_t	1.617	0.381 (4.242)
$YVAR_t$	-0.138	0.036 (-3.778)
R^2 / DW	0.376 / 0.656	

Table 9: Estimates for equation (14)

All coefficients are highly significant and β is positive so that sustainability cannot be rejected. As our regression shows the US government tried to compensate the additional

debt by running a higher surplus a year later. Interestingly, a negative value of the business cycle is estimated. As in the case of Portugal, a growing economy will reduce the surplus. Also, if a social surplus is produced the surplus will be reduced, meaning that the government will take advantage of the good social position and lowers its efforts to run a surplus. Our conjecture of a low R^2 and a poor DW-statistic is verified, they take values of 0.375 and 0.656 respectively. Table 10 summarizes the results for the next estimations.

	Dependent variable: s_t		Dependent variable: s_t^{soc}		Dependent variable: s_t^{soc}	
	Coeff.	*Std. Error*	*Coeff.*	*Std. Error*	*Coeff.*	*Std. Error*
constant	-0.044	0.015 (-2.853)	-0.063	0.015 (-4.114)	-0.036	0.016 (-2.299)
b_{t-1}	0.167	0.037 (4.515)	0.164	0.037 (4.453)	0.041	0.028 (1.497)
Int_t	1.310	0.363 (3.607)	1.821	0.324 (5.613)		
$YVAR_t$	-0.178	0.044 (-4.071)	-0.111	0.040 (-2.768)		
R^2	0.289		0.342		0.048	
DW	0.409		0.794		0.548	

Table 10: Estimates for equation (15), equation (16) and equation (17)

The poor quality of our estimation remains and suggests to include other variables to properly model the outliers in these time series. Yet, all parameters are significant and the β's have the expected sign. Finally, our findings seem to verify Bohn's results when he characterized the US fiscal policy to be sustainable even if we do not use the same data and include additional components in the framework.

It should also be mentioned that for the US interest rates have been lower than the growth of GDP which would indicate dynamic inefficiency. However, in a stochastic framework it is the relation between the growth rate and the rate of return on risky capital which determines whether an economy is dynamically efficient and Abel et al. (1989) provide strong evidence that the US economy is dynamically efficient.

4 Conclusion

This paper has analyzed the question of whether fiscal policy is sustainable in selected Euro-area countries. We have focused on those countries which are characterized by a high debt ratio or which recently have violated the three percent Maastricht deficit criteria. We have undertaken this study by following up an approach that Bohn (1998) has developed to study sustainability of fiscal policy in the US. Theoretically we could show that if the primary surplus to GDP ratio of the government increases linearly with a rising ratio of public debt to GDP the fiscal policy is sustainable for dynamically efficient economies.

Our empirical results suggest that fiscal policies in the countries under consideration are sustainable. The reason for this is that governments take corrective actions as a result of rising debt ratios by increasing the primary surplus ratio. This, however, implies that the intertemporal budget constraint of the government, which should be fulfilled in the far future when time approaches infinity, has immediate implications for the period budget constraint.

So, the compliance with the intertemporal budget constraint implies that either public spending must decrease with a rising public debt ratio or the tax revenue must increase. Looking at real world economies one realizes that it is not a rise in the tax revenue but a decline in public spending which generates primary surpluses. As to the component of public spending which has been reduced mostly, it can be seen that in many countries public investment has been decreased. Public investment is likely to be the variable that can be reduced most easily. Thus, the decline of public investment as a result of a rising public debt may be explained, a fact which can also be observed empirically (see e.g. Gong, Greiner and Semmler, 2001, or Heinemann, 2002). Thus, in the long-run high debt ratios may have negative repercussion for the growth rates of economies.[16]

[16]For details see Greiner, Semmler and Gong (2003), chap. 6.

5 Appendix: Proposition 2 with a time-varying interest rate and GDP growth rate

If equation (7) holds and the interest rate and the GDP growth rate are not constant the discounted level of government debt, $e^{-\int_0^t r(\tau)d\tau}B(t)$, is given by

$$e^{-\int_0^t r(\tau)d\tau}B(t) = e^{-\beta t}\left(B(0) - \alpha Y(0)\int_0^t e^{\beta\tau - \int_0^\tau (r(\mu)-\gamma(\mu))d\mu}d\tau\right),$$

with $r(\cdot)$ and $\gamma(\cdot)$ the time varying interest rate and GDP growth rate, respectively, and α and β as in (7). For $\beta > 0$ and $\alpha \geq 0$ it is immediately seen that the intertemporal budget constraint holds. For $\beta > 0$ and $\alpha < 0$ the intertemporal budget constraint holds for $\int_0^\tau r(\mu)d\mu > \int_0^\tau \gamma(\mu)d\mu$. Thus, Proposition 2 basically also holds for nonconstant interest rate and GDP growth rate.

6 Appendix: Data

Source: OECD Economic Outlook Statistics and Projections

We use the Data Set corresponding to those published in the June 2003 issue of the OECD Economic Outlook. Especially, we take the entire Data set for the Government Account and the series for Gross Domestic Product at Market prices (GDP)

The Data for the 4 Euro area countries are expressed in euro (EUR). For each country, pre-1999 data were converted from national currency using the irrevocable conversion euro rates. The data are expressed in millions of EUR or USD respectively.

References

[1] Abel, A.B., G.N. Mankiw, N. L.H. Summers and R.J. Zeckhauser (1989), "Assessing dynamic efficiency: Theory and evidence," *Review of Economic Studies*, Vol. 56: 1-19.

[2] Arby, M. F. (2001), "Long-run Trend, Business Cycles and Short-run Shocks in Real GDP," *State Bank of Pakistan Working Paper*, No. 01
(URL: http://www.sbp.org.pk/publications/wpapers/wp01.pdf).

[3] Blanchard, O., J.-C. Chouraqui, R. P. Hagemann and N. Sartor (1990) "The sustainability of fiscal policy: New answers to an old question," OECD Economic Studies, No. 15, Autumn.

[4] Blanchard, O.J. and S. Fischer (1989), "Lectures on Macroeconomics," The MIT Press, Cambridge, Massachusetts.

[5] Bohn, H. (1991a), "Budget balance through revenue or spending adjustments?", *Journal of Monetary Economics*, 27: 333-359

[6] Bohn, H. (1991b), "The sustainability of budget deficits with lump-sum and with income-based taxation", *Journal of Money, Credit and Banking*, Vol. 23, No. 3, (August 1991, Part 2): 581-612.

[7] Bohn, H. (1995), "The sustainability of budget deficits in a stochastic economy" *Journal of Money, Credit and Banking*, Vol. 27, no. 1: 257-271.

[8] Bohn, H. (1998), "The behaviour of U.S. public Debt and deficits" *Quarterly Journal of Economics*, Vol. 113: 949-963.

[9] Diamond, P.A. (1965), "National debt in a neo-classical growth model," *The American Economic Review*, Vol. 55: 1126-1150.

[10] Greiner, A. and W. Semmler (1999), "An inquiry into the sustainability of German fiscal policy: Some time series tests," *Public Finance Review*, Vol. 27: 221-237.

[11] Greiner, A., G. Gong and W. Semmler (2001), "Growth effects of fiscal policy and debt austainability in the EU", *Empirica, Journal of Applied Economics and Economic Policy*, Vol. 28, no. 1.

[12] Greiner, A., W. Semmler and G. Gong (2003), "The Forces of Economic Growth: A Time Series Perspective", forthcoming, Princeton Unversity Press.

[13] Grüne, L., W. Semmler and M. Sieveking (2003), "Creditworthiness and thresholds in a credit market model with multiple equilibria", forthcoming, *Economic Theory.*

[14] Hamilton, J.D. and M. Flavin (1986), "On the limitations of government borrowing: A framework for empirical testing," *The American Economic Review*, Vol. 76: 808-819.

[15] Heinemann, Friedrich (2002), "Factor mobility, government debt and the decline in public investment" *ZEW Discussion Paper*, No. 02-19
(URL: ftp://ftp.zew.de/pub/zew-docs/dp/dp0219.pdf).

[16] Kremers, J.M. (1988), "US federal indebtedness and the conduct of fiscal policy," *Journal of Monetary Economics*, Vol. 23: 219-238.

[17] McCallum, Bennett T. (1984), "Are bond-financed deficits inflationary? A Ricardian analysis," *Journal of Political Economy*, Vol. 92, No. 1: 123-135.

[18] Newey, W.K. and West, K.D. (1987), "A simple, positive-definite, heteroskedasticity and autocorrelation consistent covariance matrix." *Econometrica*, Vol. 55: 703-708.

[19] Sidrauski, M. (1967), "Rational choice and patterns of growth in a monetary economy," *The American Economic Review*, Papers and Proceedings, Vol. 57: 534-544.

[20] Trehan, B. and C.E. Walsh (1991) "Testing intertemporal budget constraints: theory and applications to US Federal budget and current account deficits," *Journal of Money, Credit and Banking*, Vol. 23: 206-223.

[21] White, H. (1980), "A Heteroskedasticity-Consistent Covariance Estimator and Direct Test for Heteroskedasticity." *Econometrica*, Vol. 48: 817-838.

[22] Wilcox, D. W. (1989), "The sustainability of government deficits: Implications of the present-value borrowing constraint," *Journal of Money, Credit and Banking*, Vol. 21: 291-306.