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DEVELOPMENT OF METHODS AND TECHNOLOGIES OF INFORMATICS FOR PROCESS MODELING AND MANAGEMENT

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Jan Studzinski
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This book consists of papers describing applications of informatics in process modeling and management and in environmental engineering. Problems presented in the papers concern development of methods supporting process management, development of calculation methods for process modeling and development of technologies of informatics for solving some problems of environmental engineering. In several papers results of the research projects supported by the Polish Ministry of Science and Higher Education are presented.

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CHAPTER 2

Tools of mathematical modeling; neuronal nets

DEBT SUSTAINABILITY MODELLING CASE STUDIES FROM EURO-AREA COUNTRIES*

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Abstract: *In this paper we consider a national debt sustainability problem in the Euro area countries. We apply and extend an approach developed by Bohn (1998) who proposes to study whether the inter-temporal budget constraint of the government holds by modeling the public debt to GDP ratio as a mean-reverting process which is free from arbitrary discount rates that other approaches need to assume. This paper is concerned with formal econometric procedures that allow one to test for the sustainability of fiscal policy. In our empirical studies 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).*

Keywords: Government debt sustainability, budget constraints, European Monetary Union, econometric procedures.

1. Introduction

Uncertainty about future macroeconomic conditions and fiscal policy inevitably weakens the basis for drawing compelling policy conclusions using different analyses. This paper proposes a methodology that improves our understanding of the debt dynamics - a more nuanced and more credible assessment of long-term sustainability results.

In the public debt context (McKay, 1999), a sustainable position is often viewed as one where the government (or public sector) is solvent (Buiter and Kletzer, 1997). To be deemed solvent, a government must be expected to honor current and future financial obligations, including the implicit commitment to continue providing certain public goods, services, and transfers over an indefinite future. Solvency thus implies that the present value of government expenditure (including inherited debt amortization, interest payments, and non-interest expenditure) should not exceed the present value of revenues. In other words, the present value of future

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revenues *net of* non-interest spending (or primary balances) should at least cover the existing public debt (Government must play Non-Ponzi game).

Despite its conceptual simplicity, the forward-looking nature of solvency makes it difficult to assess in practice. No one knows for sure the primary surplus a government will be able (or willing) to generate in 5, 10 or 20 years, nor the future path of interest rates, inflation, and productivity growth over that period. Absent uncertainty, of course, assessing sustainability would be a mere arithmetical exercise. In an uncertain world, however, any statement contingent on future developments involves a dose of judgment, and, more importantly, the recognition that the latter is subject to risk (Krawczak et al., 2000, 2003).

In practice, assessments of debt sustainability - including those performed by IMF country teams (Abiad and Ostry, 2005; The International Monetary Fund. The World Bank, 2002) - rely on medium-term simulations of the debt-to-GDP ratio given specific macroeconomic forecasts and fiscal policy assumptions. In the absence of reliable "sustainability thresholds" however, such estimates per se do not allow one to determine the sustainability of a particular public debt position. Instead, the expected *dynamics* of the debt-to-GDP ratio over the medium term (generally 5 to 10 years) are interpreted as a signal as to whether underlying policies can be sustained under plausible macroeconomic conditions without endangering solvency. Specifically, a declining trend in the debt ratio signals that government policies are unlikely to jeopardize sustainability, whereas a positive trend or even stabilization at a high level may motivate concerns about sustainability, especially if other factors - such as the fiscal adjustment needed to stabilize or reduce the debt ratio - point to likely difficulties in keeping debt under control.

The public, academic debate on the deficit and debt of the Euro-area countries 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 macro-economy any longer.

This paper is focused with formal econometric procedures that allow one to test for the sustainability of fiscal policy. What we are 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 selected member countries.

The question of how large a private agent's debt can become, from the theoretical point of view, 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.

There are limits of borrowing capacity of economic agents which are usually defined by the inter-temporal budget constraints of the agents.

From the theoretical point of view for government debt this question has somewhat been left unsettled. 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. However, that possibility is not given any longer when the economy is dynamically efficient (Buiter and Kletzer, 1997). 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. Bohn (1995) has proved that in an exchange economy with infinitely lived agents the government must always satisfy the no-Ponzi game condition. In papers Bohn (1991a, 1991b, 1995, 1998) presents a theoretical advancement of studying sustainability of public debt and provides a new econometric approach to estimate sustainability of public debt.

Empirical studies which help to clarify whether governments follow the inter-temporal 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 (Kremers, 1988; Wilcox, 1989; or Trehan and 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.

2. Ponzi game

Infinite horizon allows agents to borrow an arbitrarily large amount without effectively ever repaying, by rolling over the principal and the interest on this debt forever. Such a scheme is known as a Ponzi game (Diamond, 1965; Blanchard and Weil, 1992). It allows infinite consumption.

Consider an infinite horizon model, no uncertainty, and a complete set of short-lived bonds. Let z^t is the amount of bonds maturing in period t in the portfolio, β_t is the price of this bond as of period t-1, y^t is consumption, w^t is wages, $u(y^t)$ is utility, δ^t is number between 0 and 1, indicating the weight that is given to utility at time t. We assume that $\delta^t > \delta^{t+1}$ for all t.

$$\max\left\{\sum_{t=0}^{\infty}\delta^t u(y^t)\ \middle|\ \begin{array}{ll} w^0 - y^0 \geq \beta_1 z^1 & for\, t=0 \\ w^t - y^t \geq \beta_{t+1} z^{t+1} \text{-} z^t & for\ t>0 \end{array}\right\}.$$

Note that the following consumption path is possible: $y^t = w^t+1$ for all t.

First of all note what this says. It says that the agent consumes *more than his endowment in each period, forever*. This can be financed with ever increasing debt:

$$z^1 = -1/\beta_1,\ z^2 = (-1+z^1)/\beta_2,\ z^3 = (-1+z^2)/\beta_3, \ldots$$

Of course, Ponzi games can never be part of equilibrium. In fact, such a scheme even destroys the existence of a utility maximum because the choice set of an agent is unbounded above. We need an additional constraint.

Table 1. Public Debt as a Percentage of GDP, 1997–2003.

Year	Germany	France	Italy	EU12
1977	26.8	20.1	56.4	31.0
1978	28.2	21.2	61.7	33.1
1979	29.2	21.2	61.0	33.8
1980	31.2	19.8	58.2	34.7
1981	34.8	21.9	60.2	38.0
1982	37.7	25.5	65.1	42.1
1983	39.4	26.9	70.0	45.9
1984	40.1	29.1	75.2	48.9
1985	40.7	30.8	81.9	52.0
1986	40.6	31.3	86.2	53.7
1987	41.6	33.4	90.4	56.0
1988	42.0	33.4	92.6	56.5
1989	40.7	34.1	95.4	56.8
1990	42.3	35.1	97.2	58.1
1991	40.4	35.8	100.6	58.6
1992	42.9	39.6	107.7	61.9
1993	46.9	45.3	118.1	67.2
1994	49.3	48.4	123.8	69.5
1995	57.0	54.6	123.2	73.0
1996	59.8	57.1	122.1	75.4
1997	61.0	59.3	120.2	75.4
1998	60.9	59.5	116.3	73.7
1999	61.2	58.5	114.9	72.7
2000	60.2	57.2	110.6	70.2
2001	59.4	56.8	109.5	69.2
2002	60.8	59.0	106.7	69.0
2003	63.8	62.6	106.4	70.4

Source: European Commission

In Ponzi game the constraint that is typically imposed on top of the budget constraint is the transversality condition,

$$\lim_{t\to\infty} \beta_t z^t \geq 0 .$$

This constraint implies that the value of debt cannot diverge to infinity. More precisely, it requires that all debt must be redeemed eventually (i.e. in the limit).

Public debts for Germany, France and Italy are presented in Table 1.

Ponzi scheme is a fraudulent investment operation that involves paying returns to investors out of the money raised from subsequent investors, rather than from profits generated by any real business. A Ponzi scheme offers high short - term returns in order to entice new investors, whose money is needed to fund payouts to earlier investors and to lure its victims into ever - bigger risks.

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 all major OECD countries (Blanchard et al., 1992), the average realized real rate return on government debt over the past last 20 years (1970s and 1980s) has been smaller than the growth rate. This implies that governments can play a Ponzi debt game, rolling over their debt without ever increasing taxes.

3. Debt sustainability - background

Change of public debt in continuous time is given by:

$$\dot{B}(t) = B(t)r(t) - S(t) , \tag{3.1}$$

where $B(t)$ is real public debt (strictly speaking, $B(t)$ should be real public net debt), $r(t)$ is the real interest rate, and $S(t)$ is real government surplus exclusive of interest payment.

Solving equation (3.1) we get for the level of public debt at time t

$$B(t) = e^{\int_0^t r(\tau)d\tau} \left(B(0) - \int_0^t e^{-\int_0^\tau r(\mu)d\mu} S(\tau)d\tau \right), \tag{3.2}$$

with $B(0)$ public debt in time $t=0$. Multiplying both sides of (3.2) with $e^{-\int_0^t r(\tau)d\tau}$, to get the present value of government debt at time t, yields

$$B(0)=e^{-\int_0^t r(\tau)d\tau}B(t)+\int_0^t e^{-\int_0^\tau r(\mu)d\mu}S(\tau)d\tau. \tag{3.3}$$

Assuming that the interest rate is constant then (3.3) becomes

$$B(0)=e^{-rt}B(t)+\int_0^t e^{-r\tau}S(\tau)d\tau. \tag{3.4}$$

If the first term in (3.4), $e^{-rt}B(t)$, 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

$$B(0)=E\int_0^t e^{-r\tau}S(\tau)d\tau, \tag{3.5}$$

with E denoting expectations. Equation (3.5) 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 (3.5) must be fulfilled is that the following condition holds:

$$\lim_{t\to\infty} Ee^{-rt}B(t)=0. \tag{3.6}$$

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

In the economics literature numerous studies exist which explore whether (3.5) and (3.6) hold in real economies (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 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 stabilizes 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.

$$\frac{T(t)-G(t)}{Y(t)}=\alpha+\beta\left(\frac{B(t)}{Y(t)}\right), \tag{3.7}$$

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, β constants. All variables are real variables. Defining $b \equiv B/Y$ the public debt to GDP ratio evolves according to the following differential equation

$$\dot{b}=b\left(\frac{\dot{B}}{B}-\frac{\dot{Y}}{Y}\right)=b\left(r+\frac{G-T}{B}-\gamma\right), \tag{3.8}$$

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

Using (3.7) the differential equation describing the evolution of the debt-GDP ratio can be rewritten as

$$\dot{b}=b(r-\gamma-\beta)-\alpha\,. \tag{3.9}$$

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

$$b(t)=\frac{\alpha}{(r-\beta-\gamma)}+e^{(r-\beta-\gamma)t}C_1, \tag{3.10}$$

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 (3.10). $\beta > 0$ 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 (3.10) converges to zero if and only if $r - \beta - \gamma < 0$ 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 inter-temporal budget constraint of the government requires that the discounted stream of government debt converges to zero. Therefore, we next study whether the inter-temporal budget constraint of the government holds, which requires $\lim_{t \to \infty} e^{-rt} B(t)$ given our assumption that the primary deficit to GDP ratio is a linear function of the debt-GDP ratio as postulated in equation (3.7). Using that equation the differential equation describing the evolution of public debt can be written as

$$\dot{B}(t) = rB(t) + G(t) - T(t) = (r - \beta)B(t) - \alpha Y(t)\,. \qquad (3.11)$$

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

$$B(t)=\left(\frac{\alpha}{r-\beta-\gamma}\right)Y(0)e^{\gamma t}+e^{(r-\beta)t}C_2 \tag{3.12}$$

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: $C_2 = B(0)-Y(0)\alpha/(r-\gamma-\beta)$. Given this expression we can state conditions which must be fulfilled so that the inter-temporal budget constraint of the government can hold.

Proposition 2. For our model economy the following turns out to hold true.

(i) For $\alpha \geq 0$ the inter-temporal budget constraint of the government holds if $\beta > 0$.

(ii) For $\alpha < 0$, the inter-temporal budget constraint of the government is fulfilled for $\beta > 0$ and $r > \gamma$.

(iii) For $\beta < 0$ the inter-temporal 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 $e^{-rt}B(t)$ as

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

For $\beta > 0$ the term $e^{-\beta t}C_2$ converges to zero for $t \to \infty$. The first term of $e^{-rt}B(t)$ 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 $e^{-rt}B(t)$ 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 $e^{-rt}B(t) \to \pm\infty$ depending on the sign of $r - \gamma - \beta$: Finally, for $\beta < 0$ the expression $e^{-rt}B(t)$ 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 $e^{-rt}B(t)$ 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 inter-temporal 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 sustainability 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 inter-temporal budget constraint is not fulfilled. However, it must be pointed out that in such economies the inter-temporal 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 inter-temporal 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 $B(0) = Y(0)\alpha/(r - y - \beta)$.

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 inter-temporal 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 drawing conclusions about the sustainability of a given fiscal policy so that empirically estimating equation (3.7) seems to be a powerful test. Yet, we might also have to control for other variables impacting the dynamics of equation (3.7).

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

4. Empirical analysis and case studies

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 idea is to estimate the following equation

$$s_t = \beta b_t + \alpha^T \mathbf{Z}_t + \varepsilon_t \qquad (3.13)$$

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.*

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. 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. In the third equation to be estimated the social surplus ratio is included in the primary surplus ratio. The last equation, finally, is equation (3.7) 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 occur at later periods.

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

$$s_t = \alpha_0 + \beta b_{t-1} + \alpha_1 Social_t + \alpha_2 Interest_t + \alpha_3 YVAR_t + \varepsilon_t , \quad (3.14)$$

$$s_t = \alpha_0 + \beta b_{t-1} + \alpha_2 Interest_t + \alpha_3 YVAR_t + \varepsilon_t , \quad (3.15)$$

$$s_t^{soc} = \alpha_0 + \beta b_{t-1} + \alpha_2 Interest_t + \alpha_3 YVAR_t + \varepsilon_t , \quad (3.16)$$

$$s_t^{soc} = \alpha_0 + \beta b_{t-1} + \varepsilon_t , \quad (3.17)$$

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 (3.14)-(3.17) 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 (White, 1980; Newey and West, 1987).

We estimated econometric models for five countries: Germany, France, Italy, Portugal and the United States (Table 2).

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.

Data source were taken from OECD Economic Outlook (published in the June 2003).

Table 2. Results on the basis econometric models (3.14 – 3.17)

Germany						
Model (3.14), dependent variable: s_t						
	Coeff.	*(t-stat.)*				
constant	-0.002	(-0.415)				
b_{t-1}	0.148	(3.467)				
$Social_t$	-0.068	(-0.266)				
Int_t	2.552	(3.810)				
$YVAR_t$	0.240	(3.967)				
R^2	0.642					
DW	1.181					
	Model (3.15)		Model (3.16)		Model (3.17)	
	Dependent variable: s_t		Dependent variable: s_t^{soc}		Dependent variable: s_t^{soc}	
	Coeff.	*(t-stat.)*	*Coeff.*	*(t-stat.)*	*Coeff.*	*(t-stat.)*
constant	-0.001	(-0.270)	-0.011	(-1.720)	-0.005	(-0.806)
b_{t-1}	0.153	(4.411)	0.078	(1.840)	0.018	(1.192)
Int_t	2.676	(5.995)	0.851	(1.609)		
$YVAR_t$	0.241	(4.103)	0.219	(3.114)		
R^2	0.641		0.241		0.038	
DW	1.177		1.045		0.883	
France						
Model (3.14), dependent variable: s_t						
	Coeff.	*(t-stat.)*				
constant	-0.012	(-0.597)				
b_{t-1}	0.077	(1.812)				
$Social_t$	-0.913	(-3.078)				
Int_t	1.256	(1.667)				
$YVAR_t$	-0.048	(-0.257)				
R^2	0.749					
DW	1.063					
	Model (3.15)		Model (3.16)		Model (3.17)	
	Dependent variable: s_t		Dependent variable: s_t^{soc}		Dependent variable: s_t^{soc}	
	Coeff.	*(t-stat.)*	*Coeff.*	*(t-stat.)*	*Coeff.*	*(t-stat.)*
constant	-0.061	(-7.655)	0.007	(-0.997)	-0.009	(-1.523)
b_{t-1}	0.140	(4.830)	0.032	(2.206)	0.012	(0.928)
Int_t	0.993	(1.447)	0.751	(1.706)		
$YVAR_t$	0.321	(-1.834)	0.194	(-0.114)		
R^2	0.683		0.294		0.031	
DW	0.941		1.076		0.657	
Italy						
Model (3.14), dependent variable: s_t						
	Coeff.	*(t-stat.)*				
constant	-0.122	(-9.461)				
b_{t-1}	0.163	(6.956)				
$Social_t$	-0.531	(-1.933)				
Int_t	0.525	(4.000)				
$YVAR_t$	0.128	(5.339)				
R^2	0.911					
DW	1.071					
	Model (3.15)		Model (3.16)		Model (3.17)	

	Dependent variable: s_t		Dependent variable: s_t^{soc}		Dependent variable: s_t^{soc}	
	Coeff.	*(t-stat.)*	*Coeff.*	*(t-stat.)*	*Coeff.*	*(t-stat.)*
constant	-0.143	(-19.393)	-0.103	(-14.045)	-0.019	(-2.963)
b_{t-1}	0.199	(18.525)	0.131	(13.246)	$2.398 \bullet 10^{-6}$	(2.438)
Int_t	0.628	(5.714)	0.434	(4.290)		
$YVAR_t$	0.138	(5.938)	0.118	(5.195)		
R^2	0.906		0.812		0.004	
DW	0.997		1.109		0.163	
Portugal						
Model (3.14), dependent variable: s_t						
	Coeff.	*(t-stat.)*				
constant	-0.083	(-7.112)				
b_{t-1}	0.164	(6.547)				
$Social_t$	0.314	(0.863)				
Int_t	-0.014	(-0.154)				
$YVAR_t$	-0.051	(-3.691)				
R^2	0.861					
DW	1.811					
	Model (3.15)		Model (3.16)		Model (3.17)	
	Dependent variable: s_t		Dependent variable: s_t^{soc}		Dependent variable: s_t^{soc}	
	Coeff.	*(t-stat.)*	*Coeff.*	*(t-stat.)*	*Coeff.*	*(t-stat.)*
constant	-0.085	(-6.789)	-0.090	(-6.829)	-0.095	(-11.588)
b_{t-1}	0.161	(7.073)	0.150	(6.663)	0.176	(10.576)
Int_t	-0.054	(-0.466)	-0.181	(-1.848)		
$YVAR_t$	-0.043	(-1.938)	-0.015	(-0.880)		
R^2	0.858		0.780		0.749	
DW	1.833		1.697		1.466	
United States (US)						
Model (3.14), dependent variable: s_t						
	Coeff.	*(t-stat.)*				
constant	-0.056	(-3.309)				
b_{t-1}	0.165	(4.683)				
$Social_t$	-0.600	(2.259)				
Int_t	1.617	(4.242)				
$YVAR_t$	-0.138	(-3.778)				
R^2	0.376					
DW	0.656					
	Model (3.15)		Model (3.16)		Model (3.17)	
	Dependent variable: s_t		Dependent variable: s_t^{soc}		Dependent variable: s_t^{soc}	
	Coeff.	*(t-stat.)*	*Coeff.*	*(t-stat.)*	*Coeff.*	*(t-stat.)*
constant	-0.044	(-2.853)	-0.063	(-4.114)	-0.036	(-2.299)
b_{t-1}	0.167	(4.515)	0.164	(4.453)	0.041	(1.497)
Int_t	1.310	(3.607)	1.821	(5.613)		
$YVAR_t$	-0.178	(-4.071)	-0.111	(-2.768)		
R^2	0.289		0.342		0.048	
DW	0.409		0.794		0.548	

Source: Own investigations

In all models β is positive so that sustainability cannot be rejected.

5. Conclusions

Recognizing the important role that public debt management can play in helping countries cope with economic and financial shocks. Public debt management is the process of establishing and executing a strategy for managing the government's debt in order to raise the required amount of funding, pursue its cost and risk objectives, and to meet any other public debt management goals the government may have set, such as developing and maintaining an efficient and liquid market for government securities (Barro, 1995; The International Monetary Fund. The World Bank, 2002). Drawn up above econometric procedures can help in public debt management process and hold in long term the debt sustainability.

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 inter-temporal 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.

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Jan Studzinski, Olgierd Hryniewicz (Editors)

DEVELOPMENT OF METHODS AND TECHNOLOGIES OF INFORMATICS FOR PROCESS MODELING AND MANAGEMENT

The purpose of this publication is to popularize application of informatics in process modeling and management and in environmental engineering. The papers published are thematically selected from the works presented during the conference '*Multi-accessible Computer Systems*' organized by the Systems Research Institute and the University of Technology and Agriculture in Bydgoszcz for several years already in Ciechocinek. Problems presented in the papers concern: development of quality and quantity methods supporting the process management, development of quantity methods for process modeling and simulation, development of technologies of informatics for solving problems of environmental engineering. In several papers results of research projects supported by the Polish Ministry of Science and Higher Education are presented.

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