The Sustainability of Public Finances and Europe's Fiscal Rules

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The Sustainability of Public Finances: Has Europe's Stability and Growth Pact Made a Difference?

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Abstract: One argument for constraining European fiscal policy under the rules of the Stability and Growth Pact (SGP) is the need to ensure the sustainability of public debt. But has the SGP made a difference in this respect? This paper first provides a new approach to analyzing the concept of debt sustainability under the Maastricht rules and then tests formally whether actual policies have been sustainable in the past and whether the start of monetary union has changed policy behaviors. The result is that the Pact has not changed policy behavior, although European fiscal policies have been sustainable. Furthermore, Monetary union has improved the economic environment within which fiscal policy remains sustainable.

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Is a monetary economy sustainable without fiscal discipline? For centuries, evidence has proven that very large public borrowing and debt will destabilize debtor-creditor relations and therefore the proper functioning of a monetary economy. However, it is also clear that small deficits are perfectly compatible with rapid economic growth and price stability.[2] The question then is: when are the deficits excessive and debt unsustainable? This issue was one of the major sticking points during the Maastricht negotiations setting up European monetary union (Bini-Smaghi, Padoa-Schioppa, Papadia, 1994). After a long debate and European-wide deliberation (Stark, 2001; Costello, 2001), the European Union has settled on an original framework to manage public finances, called the Stability and Growth Pact (SGP). It defines two sets of fiscal rules: (i) the Excessive Deficit Procedure (EDP) according to article 104 of the Treaty, which sets a hard ceiling for actual deficits at 3 percent of GDP, to be exceeded only in exceptional circumstances; it also formulates the softer constraint of a debt/GDP ratio below 60 percent, which may be overshot, provided it subsequently is "sufficiently diminishing and approaching the reference value at a satisfactory pace" (Treaty of European Union, art. 104c). Violating theses rules obligatorily triggers off a sequence of *corrective measures* with the purpose of returning to positions below the ceilings. (ii) The Stability and Growth Pact *strictu sensu*[3]*,* agreed at the Amsterdam European Council in 1997, specifies the application rules for the EDP aiming to *prevent* the obligatory need for corrections. Other than procedural regulations and requesting member states to present medium-term Stability Programs for their public finances, it stipulates maintaining cyclically adjusted (also called *structural*) budget positions "close to balance or in surplus." [4] Following this second set of rules would provide sufficient space for the working of the automatic stabilizers (Dalsgaard and Serres, 2001) and would ultimately reduce debt/GDP levels to zero (de Grauwe, 2005).

In recent years policy makers have become increasingly concerned with the consequences of aging and the issue of long-term fiscal sustainability (Eckefeldt et al,

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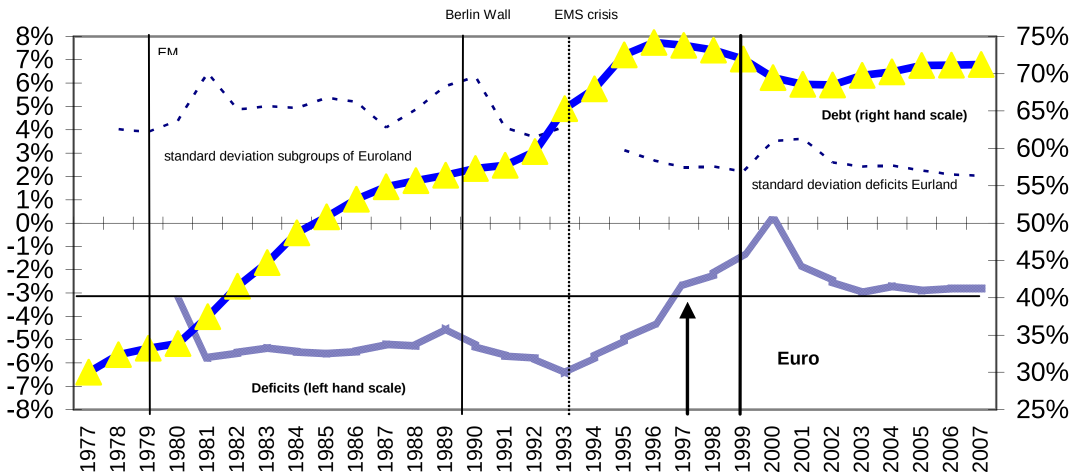
[2] At least for a reasonable degree of price stability. Woodford (1996) shows, however, that fiscal instability with non-ricardian effects necessarily results in price level instability.

[3] Strictly speaking, the Stability and Growth Pact is secondary legislation in the form of two Council Regulations (EC Council Regulation 1466/97 and 1467/97. These Council Regulations have been amended by the "reform" of the SGP in 2005 (see EC Council Regulations 1055/2005 and 1056/2005).

[4] The interpretation of the formulation "close-to-balance over the medium term" is now generally accepted to mean balanced structural budget positions. See European Commission, 2002.

2005). A low debt ratio should provide the European Union with a sufficient "buffer" against the pressures that population aging will put on government budgets. The Stability and Growth Pact was revised in 2005 to include sustainability concerns into the definition of medium-term budget objectives. The questions, whether the SGP contributes to fiscal sustainability is, therefore, not only of academic interest.

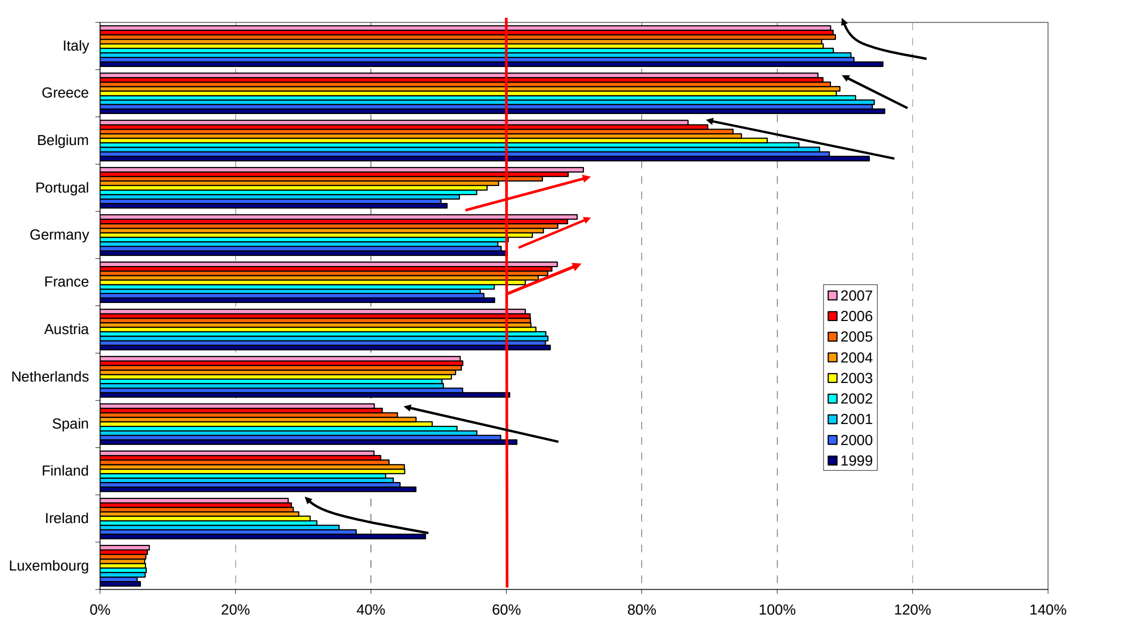
Figure 1. Debt and Deficits in Euroland
as percent of GDP



With respect to the stipulated fiscal rules, the actual implementation of the SGP has been doubtfully successful. Figure 1 shows the debt/GDP and deficit ratios for Euroland. The deficit ratio stood continuously at 6 percent through the 1980s and early 1990s, while the debt ratio shot up from 30 to over 60 percent. After signing the Maastricht treaty and the ERM crisis in 1993, significant efforts of fiscal consolidation eliminated the aggregate deficit in the following seven years and slowly lowered the debt ratio. Yet, after the boom year 2000, deficits returned and stabilised just below three percent. It looks as if the Excessive Deficit Procedure has shifted the aggregate deficit ratio of the Eurozone to a permanently lower, but not to a balanced level. The debt ratio reached a peak in 1996 and started to diminish subsequently, when interest rates were coming down and growth resumed. Clearly, the rising trend has been broken, but is it sustainable? [5] Since 2002 it has risen again by 3 points. Are the movements after 1996 oscillations on the way to a stable equilibrium or do they reflect random shocks around or on the way to equilibrium?

One may argue that in sub-optimal currency area, fiscal policy needs more flexibility across countries. Yet, since the Maastricht Treaty was signed, fiscal policy has become more homogenous. The standard deviation of budget deficits across the Eurozone[6] has had a tendency to fall, although income from mobile telephone licenses sold in 2000 had some asymmetric effects. The debt ratios in individual countries do not reflect a homogenous implementation of the SGP. Portugal, Germany and France have had rising debt/GDP ratios, while in all other countries they have fallen (Figure 2).

Figure 2. Euroland Debt/GDP Ratio

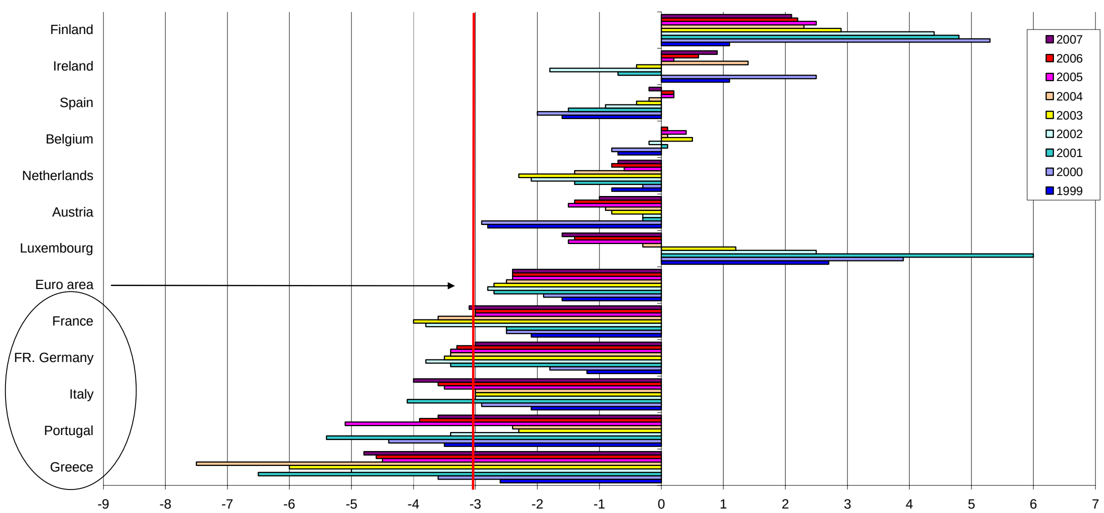


Furthermore, only Finland and in the early years Luxemburg and on occasion Ireland, Spain and Belgium have complied with the rule of structural balances close to zero or in surplus (Figure 3). Non-compliance has prevented the automatic stabilizers to

[5] ADF unit root tests indicate that a unit root cannot be rejected for the 1977-2007 sample; but it can be rejected for the 1996-2007 period, if we include a deterministic time trend (which is negative). The two respective ADF-test statistics are 1.383 [0.8445] and 6.4677 [0.0011].
[6] Before 1993, this value reflects less than 11 members of the Eurogroup.

work effectively, when actual deficits hit the 3 percent limit during slow growth periods. In fact, France, Germany, Italy, Portugal and Greece all have structural deficits in excess of 3 percent. This does not only constrain automatic stabilizers, but it even imposes procyclical fiscal consolidation.

Figure 3. Structural Deficits in Euroland 1999-2007
(based on potential GDP)



Source: Ameco, Nov. 2005.

In 2005, the European Spring Council has relaxed the balanced structural budget rule, authorizing now a structural deficit of 1 percent, given certain conditions. With the natural rate of unemployment (or the NAIRU) being quite high in some countries, this may be justified. But the SGP has remained a subject of controversy. From the beginning, the rules of the pact were subjected to extensive criticism (see Buiter, Corsetti and Roubini, 1993; Eichengreen and Wyplosz, 1998; Artis and Winkler, 1999; Buti and Giudice, 2002; Papademos, 2006). While it is widely acknowledged that debt sustainability is desirable to preserve the stability of the financial system, most critics have argued that the provisions of the pact are too rigid, impede the growth dimension in the pact and do not sufficiently focus on public debt[7].

[7] For a review of criticisms see Montanino, 2004.

The first line of criticism emphasizes the role of deficits in the policy mix, i.e. the interaction of fiscal and monetary policy in maintaining the equilibrium between aggregate supply and demand. Some authors are concerned with asymmetric shocks and regional transfers (Obstfeld and Peri, 1998; Fatás, 1998). Yet, one needs to emphasize that what matters for stabilization policy in a monetary union is the *aggregate budget position* and not individual country's deficits, because the counterpart to a single monetary policy is overall public sector borrowing (Collignon, 2004). In a large, fully integrated single market with a single currency, regional net spending may affect local demand, but hardly local supply, which may be sourced from anywhere. Thus, local budget deficits are of little relevance for stabilization policy, even in case of asymmetric shocks. Furthermore, the potential disturbance for price stability caused by fiscal policy derives from the aggregate fiscal position (Woodford, 1996). Fiscal policy should stimulate economic activity for the whole Eurozone if resources are underemployed, and it should impose fiscal restraint when production is above potential. By definition, these stabilizing fiscal adjustments are temporary. Permanent or cyclically adjusted budget balances reflect intertemporal preferences for the distribution of tax burden, and here the issue of sustainable debt positions becomes salient.

The second line of criticism looks at the sustainability of public debt and resulting risks for the financial system and long term growth. If debt levels are unsustainable, the risk premium in interest rates on government debt augments and the risk of default increases. Furthermore, if the public perceives the debt level to be non-stationary, higher debt/GDP levels imply lower capital-income ratios (less investment) and therefore lower economic growth and lower productivity (Friedman, 2006). Thus, the issue of debt sustainability in Europe is crucial for the long term evolution of economic growth and possibly even for the sustainability of European monetary union itself. However, Collignon and Mundschenk (1999) have argued that participating in European monetary union would strengthen fiscal sustainability, a policy bet that was also made by the Italian government in 1997 (Spaventa and Chiorazzo, 2000). While accepting the necessity of the long-term sustainability of debt, some critics argue that governments should have more borrowing flexibility if their debt levels are low (H.M.

Treasury, 2003; Calmfors and Corsetti, 2003; Saraceno and Monperrus-Veroni, 2004). Public authorities should be able to choose how they redistribute the burden of paying taxes for public goods over generations and time. Others emphasize the need to take into account all future assets and liabilities, in particular pension liabilities (Coeuré and Pisani-Ferry, 2005). The argument then becomes one about the permissible non-transitory deficit, i.e. about the structural deficits, reflecting fundamental choices of intergenerational justice. This raises issues beyond the question whether fiscal policies are sustainable, notably the issue of democracy (Collignon, 2004, 2003).

In this paper, I will focus on how Europe's fiscal framework affects debt levels. I will ask whether the SGP is necessary to guarantee the sustainability of public debt in Europe and whether it has made a difference in the behavior of policy-makers since European monetary union started. The paper is structured as follows. Part 1 will clarify the theory linking Europe's fiscal policy rules with debt sustainability. Part 2 will estimate European fiscal policy reaction functions. Part 3 will test whether the behavior of public authorities has changed with the new fiscal regime of the SGP after EMU started.

1. Theory

1.1 The Concept of Fiscal Sustainability.

What is a sustainable fiscal policy? No universally accepted definition exists, but scholars agree that an exploding debt is not sustainable. An ever-rising ratio of debt to income would require governments to increase taxes and/or reduce expenditure to service the debt. Such policy cannot go on for ever. So what is an optimal policy? A good starting point for the analysis is the funding constraint:

$$(1) \qquad G_t + i_t D_{t-1} = T_t + \Delta D_t + \Delta M_t$$

where G is the level of government spending net of interest payments, T is tax revenue, i is the interest rate on government debt and D is the stock of public debt. The difference between government spending net of interest and tax revenue is called the primary budget position. Government expenditure on public goods and interest payment to bond holders are financed by taxes, increases in debt held by the private sector and monetized debt held by the central bank. ΔM is the increase in base money. We will assume that the central bank will not monetize government debt, so that $\Delta M = 0$. Relating these arguments to GDP,[8] the funding constraint can be written as (see also de Grauwe, 2005:225):

(2) $$\Delta d_t \equiv d_t - d_{t-1} = (r_t - y_t)d_{t-1} - s_t$$

The increase in the debt/GDP ratio depends on the balance between the growth adjusted debt service and the primary surplus. Equation (2) says that the debt ratio will be increasing indefinitely if the real interest rate *r* exceeds the growth rate *y*, unless the primary budget yields a sufficient surplus. We will call the relation of real interest rates to growth the *economic environment* and the level of the primary surplus the *fiscal policy stance*. If, but only if, the environment is exogenously given, stability of debt hinges exclusively on the fiscal policy stance. Otherwise, the policy mix may affect long term fiscal sustainability. However, for the sake of simplicity, we will mostly ignore the interdependencies between policy and environment, although we will not assume, as the literature usually does, that the economic environment is stable. At the end of the paper, we will qualify this assumption.

Note also that the absolute debt level D_t grows by the amount of the current deficit, which consists of the primary deficit plus nominal interest charges.[9] As a consequence, the deficit/GDP ratio is

(2a) $$def_{t+1} = \Delta d_{t+1} + (y + \pi)d_t = (r + \pi)d_t - s_{t+1}$$

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[8] $r = i - \pi$, where π is the rate of inflation (GDP deflator). (*r-y*) is sometimes also called the growth-adjusted real interest rate. d_t for the debt/GDP ratio (*D/Y*) at date *t*, $s_t = (G_t - T_t)/Y_t$ is the ratio of the primary surplus to GDP. y_t stands for the real growth rate of the economy in period *t* and *r* is the equivalent real interest rate

[9] In reality the debt level varies also because of stock-flow adjustments which encompass factors outside the government budget, such as revaluation of debt issued in foreign currency, proceeds from privatisations or debt take-overs from other sectors of the economy, accumulation of financial assets and statistical errors.

with π for inflation rate.

If a government borrowed (i.e. increased the stock of debt) to service the debt (a flow), a behavior also known as Ponzi-scheme, the debt ratio would increase until tax payers and bondholders become unwilling to pay. The repudiation of debt may then take the form of outright annulation, monetisation (Sargent and Wallace, 1981) and/or inflation (Calvo, 1988). The sustainability literature has focused on two conditions: a *weak* solvency constraint whereby the debt-GDP ratio will "eventually converge back to its initial level" (Blanchard et al., 1990: 12). This implies that the debt-GDP ratio is first difference stationary, i.e. it fluctuates around a long term constant mean. A solvency constraint defines sustainability by the maximum level of debt, which governments can sell to bondholders without ever having to repudiate debt (Blanchard, 1984). Strong solvency therefore requires weak solvency together with a stationary primary-surplus/GDP ratio (Luzenberger, Imbriani and Marini, 1994). In other words, weak solvency guarantees a stable debt/GDP ratio in the long run (steady state), while strong solvency also requires long-term stability of the policy stance. A well developed literature has sought to assess the time series properties of fiscal variables, including their co-integration (Trehan and Walsh, 1988, 1991; Wilcox, 1989; Hamilton and Flavin, 1986; Aschauer, 1985; Barro, 1984. For a review see Artis and Macellino, 1998 and for a critique Bohn, 1998). Collignon and Mundschenk (1999) have estimated maximum debt levels for EMU countries derived from the willingness to pay and found that all member states, with the exception of Italy, have historically operated well below these maximum debt levels.

Another way of formulating the concept of sustainability is to say that the public funding arrangements should allow the continuation of a given policy stance into the infinite future without violating solvency constraints (Frenkel and Raisin, 1996). By re-writing the debt dynamics as

(2a) $d_t = (1 + r_t - y_t)d_{t-1} - s_t$

we get the possible paths of public debt implied by arbitrary sequences of fiscal policies (primary surpluses s_t) and economic environments ($r_t - y_t$):

(3) $$d_{t+n} = \left(\prod_{k=0}^{n} \left[1+(r-y)_{t+k}\right] \right) \cdot d_{t-1} + \sum_{j=0}^{n} \left(\prod_{k=j+t}^{n} \left[1+(r-y)_{t+k}\right] \right) s_{t+j}$$

The question is: Under which conditions is the path of the debt ratio sustainable? To answer this question, much of the sustainability literature has imposed some simplifying and arbitrary conditions, notably by assuming the economic environment as given and constant. The accumulation of debt over several periods *t=1…n* then leads to:

(3a) $$d_{t+n} = (1+r-y)^n d_t - \sum_{j=o}^{n} s_{t+j}(1+r-y)^{n-j}$$

which implies, the present value of public debt in period *t+n* is equal to the initial public debt in period *t* minus the present value of all future primary surpluses:

(4) $$\frac{1}{(1+r-y)^{t+n}} d_{t+n} = d_t - \sum_{j=1}^{n} \frac{s_{t+j}}{(j+r-y)^j}$$

Fiscal policy satisfies sustainability, if there is a trajectory such that the present value of all expected future primary surpluses equals the initial debt, i. e.

(5) $$d_t = E\left(\sum_{j=o}^{\infty} \frac{s_{t+j}}{(1+r-y)^j} \right)$$

Otherwise bond holders would expect that part of their financial claims will not be repaid, the government would run a Ponzi-scheme and therefore, investors would refuse holding such claims. The equivalent of (5) is the so-called transversality condition (see Bohn, 2005):

(6) $$\lim_{n\to\infty} \frac{1}{(1+r-y)^n} d_{t+n} = 0$$

It is immediately apparent that the transversality condition (6) requires r>y, i.e. an economic environment of dynamic efficiency[10]. However, empirically, it is not clear that the assumption of a stable macroeconomic environment with r>y always holds. Bohn (1995, 2005) documents that average economic growth in the US economy has usually exceeded the average interest charge over the last 200 years. In Europe, such long time series are not available, but we will see below that here, too, growth rates have often exceeded after-tax interest rates over the last quarter of a century. This

[10] For a deterministic model of dynamic efficiency, also known as the Keynes-Ramsey rule, see Blanchard and Fischer, 1989.

seems odd. It would imply that governments can run Ponzi schemes for centuries. Yet, as Abel et al. (1989) and Zilcha (1992) have shown, in a stochastic economy, dynamic efficiency depends on the relation between the growth rate and the return on "risky" assets. If government debt is considered "safe", economic growth rates may well exceed low interest on government debt, especially when after-tax bond returns are considered. With time-varying growth and interest rates, we cannot assume a fixed and given economic environment. Fiscal policy, economic growth and interest rates on government debt are stochastic variables. This has significant theoretical and empirical consequences.

First, in a stochastic setting, the transversality condition (6) requires a zero limit of future government debt discounted not at the going average bond rate, but at a rate that depends on the probability distribution of revenues and spending across states of nature (Bohn, 1995: 258). However, empirically it is difficult to estimate such a rate from a single observed time series of fiscal data. Secondly, the stochastic model imposes almost no restrictions on the average level of primary deficits because the government can trade off primary deficits in some states of nature against surpluses in other states. Therefore, econometric tests for stationarity are ill suited to check for sustainability. Instead, what matters is how governments behave when pursuing their fiscal policy objectives in an uncertain world. Bohn illustrates this by giving the example of a government with a fixed target for the debt-GDP ratio: If the average interest rate is below the average growth rate, the debt ratio at the beginning of the next period will be below the target level. The government can then run a primary deficit in the following year. A surplus is only needed when growth falls below the rate of return on government bonds and the government pursues a debt target. Thus, whether fiscal policy is sustainable or not depends on the sign of the fiscal policy reaction with respect to the target: if an increase in debt is followed by an increase in primary surpluses, debt is sustainable.

Bohn (1998) has estimated the US reaction function for the primary surplus in response to a marginal increase in government debt. He finds significant reaction coefficients of the order of 2.8 and 5.4 percent and he concludes that "this provides reliable information about sustainability, regardless of how interest rates and growth rates compared" (p. 960). He recognizes that "permanent primary deficits will lead to excessive debt accumulation in at least some 'bad' states of nature", noting, however, that "a strictly positive and at least linear response of primary surpluses to the debt ratio is sufficient for sustainability". The question then is what drives the accumulation of debt and how long does it take to revert? Thus, the key is the fiscal policy reaction function. The excessive deficit procedure of the Maastricht Treaty formulates a fiscal policy rule. Does it assure European public finances of sustainability?

1.2 The European Fiscal Policy Rules

The essence of the European fiscal rules rules consists in the correction of fiscal imbalances, once certain reference values have been exceeded. Under the excessive deficit procedure, the reference values are 3 percent for the deficit and 60 percent for the debt level. Under the SGP, a zero structural deficit replaces the 3 percent rule. Note that these reference values are normatively not justifiable. No theory can explain why these or any other values are "best". All we can judge is whether they are consistent. It is sometimes argued that because of (2a) the fiscal reference values in the Maastricht Treaty of 3% for deficits and 60% for the debt ratio are mutually consistent, assuming a nominal growth rate of 5% (DeGrauwe, 2003). However, it is more appropriate to say that the reference values imply a minimum nominal growth rate consistent with the required maximal debt ratio. If we assume 2% as the normative inflation rate compatible with price stability, then the economy has to grow at least by 3% p.a. in real terms in order to fulfill the requirements of the excessive deficit procedure. However, it seems today more realistic to assume that the growth potential of the EU economy is only 2.5 percent, while the implicit average inflation target of the ECB is closer to 1.5 percent, so that the steady state nominal growth rate would be 4 percent. In this case, only a deficit of 2.4% would be compatible with a stable debt ratio of 60%. If the deficit remained at 3 percent, the sustainable debt ratio would be 75%.

However, which debt levels are sustainable over time depends on policy behavior. Given that a *fiscal adjustment requires a variation of the primary budget* *surplus* as the only discretionary policy variable available, we formulate the fiscal policy rule as the reaction function:

$$(7) \qquad \Delta s_t = \alpha(def_{t-1} - z_1) + \beta(d_{t-1} - z_2)$$

here Δs_t is the increase in the primary surplus in period t, which reflects the correction of an overshoot over target "in the year following its identification" (EC Council Regulation 1467/97, art. 4). z_1 and z_2 are the target reference values for the deficit and debt ratio (3% or 0%, and 60% respectively) and α and β are coefficients for the adjustment speed by which governments respond to the two policy objectives. We will see below, that in the European context the coefficient α is crucial for determining the sustainability of public debt. It describes the proportion by which a government corrects the excess of a deficit after overshooting the reference value; β does the same for the debt-GDP ratio. Bohn's (1998, 2005) work for the U.S. has focused exclusively on β, but I will argue that α is theoretically more powerful and - at least in Europe - empirically more relevant as fiscal policy is determined with respect to economic flows (expenditure and revenue) rather than stocks, and this shows up in statistical significance tests below. The SGP does not demand governments to correct the full excess immediately, but only "to bring the situation to an end within a given period" (Treaty of the European Union, art. 104.7). We may therefore interpret α and β normatively as the definition of the "satisfactory pace" for reducing excessive deficit and debt levels. However, even if $\beta=0$, debt levels will fall if α is sufficiently large. If both coefficients are zero, the government does not respond at all. If $\alpha=1$, the full excess deficit is corrected in the following period. If $\alpha>1$, the government increases the primary surplus sufficiently to ensure that the deficit will remain below the reference value in the following period (ceteris paribus). For $0<\alpha<1$, fiscal adjustment is spread over several years. The "reformed" rules of the SGP of 2005 stipulate that a country should undertake a budget correction of 0.5 percent of GDP in the second year after an excessive deficit has been declared. Thus, if a country were running a deficit of 4 percent, the adjustment coefficient implicit in the new rules would be $\alpha=0.25$. In most cases β is smaller than α and closer to zero, especially when the debt level is significantly above the reference level, as it will take longer to bring debt (i.e. a stock) down than adjusting the deficit (a flow)[11]. Note however, that the fiscal policy reaction function as formulated by (7) is symmetrical, while the Excessive Deficit Procedure stipulates it as an asymmetric ceiling. As a consequence, our discussion of stability sets limiting conditions for sustainability; actual performance should in general be better than these indicators.

We will now seek to establish under which conditions the European policy rules ensure fiscal sustainability, i.e. steady states of debt and primary surpluses, and then how persistent deviations from the steady state are.

1.3. Conditions for Sustainable Fiscal Policy

1.3.1. The Steady State

By using (2), (2a) and (7) we can formulate a system of two simultaneous linear difference equations, rewritten in continuous time form as

$$(8) \qquad \begin{cases} d' = (r - y)d - s \\ s' = (\alpha(r + \pi) + \beta)d - \alpha s - z \end{cases}$$

Where the prime indicates the time derivative and the constant $z = \alpha z_1 + \beta z_2$.

Solving the difference equations for d(t) and s(t) will give us the time path of the debt ratio and the primary budget position. If these two time paths converge to a pair of inter-temporal equilibrium values, the fiscal policy is strongly sustainable, regardless of the intermediary adjustment dynamics. These equilibrium values are given by the solution for the particular integrals:

[11] Bohn (1998) found that in the US the β-reaction function showed non-linearity: the quadratic deviation term was positive and significant, indicating that the marginal response of primary surpluses to changes in debt is increasing in the debt-GDP ratio. The cubic term was insignificant.

(9) $$\bar{d} = \frac{z}{\alpha(y+\pi)+\beta}$$ $$\bar{s} = \frac{(r-y)z}{\alpha(y+\pi)+\beta}$$

If public finances are (strongly) sustainable, the debt-GDP ratio converges to a stationary position that is determined by the nominal growth rate, the reference values and the adjustment parameters. The steady state primary surplus equals the growth-adjusted debt service on the steady state debt. We assume that the reference values and the reaction coefficients are structural values determined by the political system. Yet, given that interest and growth rates vary over time, the steady state debt ratio is not constant. As European nominal growth rates have fallen in the 1980s, 90s and early 2000, the implicit steady state debt ratios have risen. Note that this effect is independent of actual budget policies, as the reaction coefficients α and β reflect medium to long term behaviour. The rise in the steady state level reflects the transversality condition in a time-varying macroeconomic environment. If we drop the ad hoc assumption of a stable economic environment, a change in the equilibrium debt level is required to compensate for the change in the discount factor (see equation 3).

Equation (9) reveals another interesting fact. If we set $\alpha=0$ and only focus on the debt response factor $\beta>0$, the equilibrium debt ratio becomes identical with the debt target. Thus, the sustainable debt ratio is arbitrary, like the Maastricht 60 percent, but if one took the reaction function responding to changes in debt, as estimated by Bohn for the USA, the steady state would always be the debt ratio realized in the previous period. Such a rule would turn sustainable debt into a random walk. It is of course, possible that U.S. authorities have an implicit debt target to which they respond. In the Europea case, the target was made more explicit by the Maastricht provisions.

Second, if $\beta=0$, the steady state for debt reflects the ratio of the deficit target to the nominal growth rate, which is 60% under the assumptions of the "Maastricht numerology". But if $\beta>0$, the steady state for the debt is lower. Note also, that if $z_1=0$, as implied in the medium term rule of the SGP, and if $\beta=0$, the steady state debt ratio and primary surplus are both zero.[12] Figure 4 shows the evolution of calculated steady state debt levels for our EU member states, given the policy reaction coefficients taken from Table 2.[13] Note the large variety between countries. Sweden and the UK have stayed flat at 60%. Only Italy and Finland dipped below a 20% debt-GDP ratio in the 1970. Finland was dramatically hit by the disappearance of the Soviet Union in the early 1990, that highly destabilized its growth rate. We also find that the slow growth period in the early 1990s pushed the equilibrium debt levels up everywhere, although higher growth in devaluating ERM countries (Italy, Spain, Ireland, Portugal) helped bringing them down again.

[12] DeGrauwe (2005:241) has made this point about the debt ratio and the deficit, but it obviously extends to the primary budget balance, which becomes identical to the deficit when the debt is zero.

[13] I have taken the coefficient with the lowest standard error. In order to reduce the noise of shocks and business cycles the nominal growth rates were calculated as a centred moving average.

Figure 4. Steady State Debt Levels based on 5-year-moving-average Growth Rates

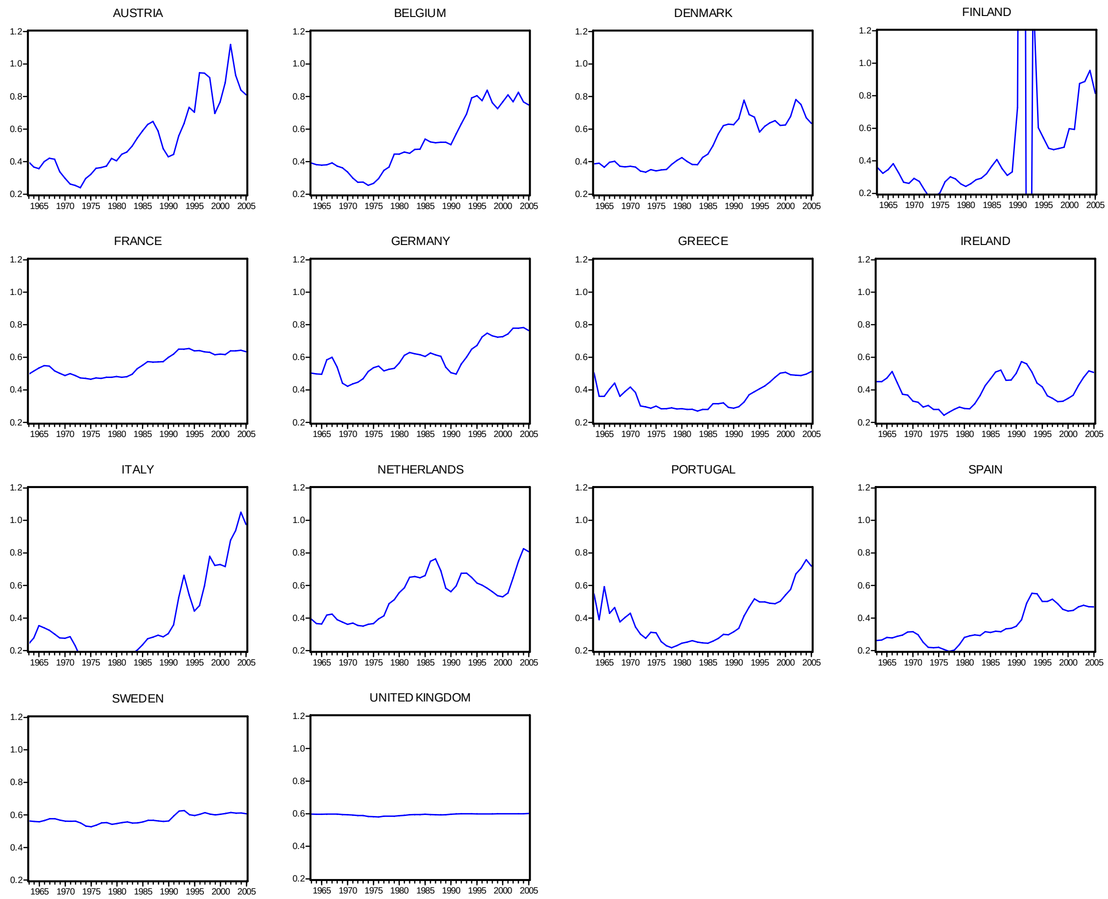


Table 1 indicates the calculated steady state values for different fiscal policy scenarios. Assuming the reference values of the Excessive Deficit Procedure (3% deficit and 60% debt) and using the estimated reaction coefficients reported in Table 3, column 1 shows the actual average debt rations for 2006 period. Column 2 calculates the steady state debt ratio assuming 2% inflation and zero growth as a limiting case; Column 3 assumes a more realistic 1.5 growth rate. At 3% growth all ratios are 60%. Columns 4 and 5 calculate the steady state debt ratios and the primary surplus ratios given the average nominal growth and interest rates for each country over the 1999-2006 period since EMU started. Only 5 countries out of 14 (we could also add Luxemburg) seem to be capable of sustaining their debt levels below 60%, as stipulated by the Maastricht Treaty. In some high debt countries like Italy and Greece, there is still a substantial gap to be closed downward; in others like Denmark, Ireland or Spain, the movement is upward. If the growth rate deteriorated significantly, the impact of sustainable debt levels would be significant. The increases in debt ratios we observed earlier in Figure 2 are compatible with debt sustainability in Germany, but for France or Portugal, this is not obvious. We also note that the countries with the lowest steady state debt ratios are those with negative growth-adjusted real interest rates. The growth dividend allows them to run limited primary deficits.

Table1. Steady State Values for Fiscal Policy

	Actual	**steady state debt** assuming inflation=2%			primary surplus
	1	***2***	***3***	***4***	*5*
	2006	***y=0***	***y=1.5%***	**Average *y* for**	**99-06**
Austria	63.5%	**135.1%**	**83.1%**	**87.9%**	0.9%
Germany	69.1%	**77.2%**	**67.5%**	**75.5%**	1.4%
Belgium	89.8%	**134.5%**	**83.0%**	**74.5%**	0.4%
Italy	108.3%	**124.4%**	**81.0%**	**73.6%**	0.4%
Denmark	32.9%	**84.7%**	**70.2%**	**66.8%**	0.4%
France	66.7%	**65.0%**	**62.4%**	**62.1%**	0.4%
UK	44.3%	**63.3%**	**61.6%**	**60.5%**	0.1%
Sweden	49.4%	**60.5%**	**60.2%**	**60.0%**	0.0%
Finland	41.4%	**59.9%**	**60.0%**	**60.0%**	0.1%
Portugal	69.1%	**29.2%**	**39.3%**	**55.0%**	-0.2%
Spain	41.7%	**74.1%**	**66.3%**	**54.3%**	-1.1%
Greece	106.7%	**77.4%**	**67.6%**	**51.6%**	-1.2%
Netherlands	53.6%	**26.1%**	**36.4%**	**43.9%**	-0.1%
Ireland	28.3%	**83.3%**	**69.8%**	**41.6%**	-2.3%

1.3.2. Stability Conditions

Next, we need to determine the conditions for the debt and primary surplus ratios to converge to the steady state. This convergence is more rapid if it proceeds in a monotonic fashion; it is slower, if the time path oscillates periodically in its convergence to equilibrium. This distinction may be politically relevant. In the periodic case, the debt ratio may temporarily rise without reflecting a lack of sustainability. For example, we observed that the debt ratio in France and Portugal has risen above the steady state. Does that mean that fiscal policy in theses countries is unsustainable? To judge this, we need to establish the conditions under which convergence occurs either periodically or monotonically. If it were periodic, fiscal policy may still be sustainable, as it will return to equilibrium in the future.

Solving the dynamic system (8) for the homogenous part yields the following condition for sustainable financial policies (for the formal proof, see Annex):

Proposition 1. *Given the policy system (8) and assuming α=0, a sufficient condition for the debt ratio's convergence to the steady state is* $\beta > (r-y)^2$.

Proposition 2. *Given the policy system (8), and assuming β=0, a sufficient condition for public finances to be strongly sustainable is*

$$\alpha > \max\left\{ r-y, \left(\sqrt{r+\pi}-\sqrt{y+\pi}\right)^2 \right\} = \alpha_{\min}$$

This implies:

(i) $\alpha_{\min} = r-y$ *is the sufficient condition if r>y*

(ii) $\alpha_{\min} = \left(\sqrt{r+\pi}-\sqrt{y+\pi}\right)^2$ *is the sufficient condition if r<y*

Proposition 3. *The time path of convergence to the steady state can take three forms given the value of* α *:*

(i) Periodic case: Damped convergence is obtained if:

$$\alpha_{\min} < \alpha < \left(\sqrt{r+\pi}+\sqrt{y+\pi}\right)^2$$

(ii) *Critical or aperiodic case:* The *critical condition for switching between cyclical (pseudoperiodic) and monotonic convergence of the debt ratio's path to the intertemporal equilibrium is* $\alpha = \left(\sqrt{r+\pi}+\sqrt{y+\pi}\right)^2$.

(iii) *Monotonic case: The necessary and sufficient conditions for rapid convergence are:* $\alpha > \left(\sqrt{r+\pi}+\sqrt{y+\pi}\right)^2$.

These are important results. They prove, first, that the short term fiscal policy reaction function is sufficient to ensure long term debt sustainability. No need for simplifying ad hoc assumptions, long-term forecasts of all future net liabilities, intergenerational accounting, etc. Long term sustainable fiscal policy is always made in the here-now. The reason is simple: if the system converges to the steady state, the transversality condition (6) is always fulfilled, even in time-varying macroeconomic models. Second, sustainability requires fiscal policy to adjust to changes in the time-varying economic environment. If the growth-adjusted real interest rate increases, higher primary surpluses are necessary to meet the minimal constraints and fiscal policy may have to tighten unless the reaction function coefficient α is already larger than the minimum. This could create a pro-cyclical bias when the growth slow-down is caused by a negative demand shock. But if there is a significant safety margin by which α exceeds $\alpha_{\min}$, the year-by-year fiscal policy can accommodate shocks without having to sacrifice sustainability. Third, it matters what interest rate we use. Because the government collects taxes from bond holders, one should use the after-tax interest rate. Because tax rate data are notoriously unreliable and only with difficulty comparable, I have mostly used pre-tax interest rates in the empirical part of this paper, although I have also calculated an after-tax growth adjusted real interest rate, based on average tax rates over the last 5 years. This gives a conservative bias to our assessment of sustainability. As Figure 4 will show, the distinction is less relevant in period of low interest rates as either measure gets dominated by the growth rate. However, with respect to after-tax rates it is also apparent that fiscal consolidation is more efficient for sustainability if it is tax-driven. An increase in the tax rate will simultaneously increase revenue and lower the post-tax interest rate, while a cut in government spending will only affect the primary surplus.

2. Estimating the Fiscal Policy Reaction Function

We will now estimate policy parameters for the European Union and then test for structural breaks, which could indicate a change in policy behavior after the creation of EMU.

We estimate the policy reaction function:

$$\Delta s_t = \alpha def_{t-1} + \beta d_{t-1} - z.$$

Several interpretations of these variables are possible:

(i) Based on our discussion in Section 1, Δs could be interpreted as a variation of the *actual primary surplus* position in response to the EDP.

(ii) But variations in the actual primary surplus reflect variations in the business cycle and therefore, distort the picture of policy reactions to exogenous shocks. It is therefore more appropriate to take the variation of the *cyclically adjusted primary surplus* (CAPS) as the variable reflecting policy responses. This is common practice followed by the European Commission.

(iii) An assessment of the sustainability of public debt under the rules of the Excessive Deficit Procedure (EDP) should use the time series of the *actual budget deficits* as the reference deficit variable.

(iv) An assessment of the Stability and Growth Pact (SGP) must take the cyclically adjusted values for government borrowing, because the Pact stipulates balanced *structural deficits*.

2.1 The Data

The European Commission AMECO Database 2004/5 was used for the variables described in Table 2. The analysis covers 14 members of the old EU-15, excluding Luxemburg. Sufficient data for the new member states were not available. Our sample covers the 27-year period 1978-2005, coinciding with the creation of the European Monetary System leading up to EMU. Our data have the advantage of being harmonized to a European standard and are widely used by policy makers. The introduction of ESA 1995 caused changes in concepts, methods, definitions and classification of the European System of National Accounts. As a consequence, some recent time series are incomplete. Where needed, missing data were substituted by the previous data set, supplied by the European Commission.

Table 2. Used variables from European Commission Ameco Database

Name	Description	AMECO code	Period covered
GDP	Gross domestic product at current market prices.	UVGD	1978-2004
Debt ratio	Gross public debt: General government consolidated gross debt:- Excessive deficit procedure (based on ESA 1995) and former definition.	UDGGL	1978-2004
Actual deficit	Balances : Net lending (+) or net borrowing (-); general government :- Excessive deficit procedure	UBLGE	1978-2004

Actual deficit	Net lending (+) or net borrowing (-); general government - Former definition Percentage of GDP at market prices (excessive deficit procedure)	UBLGF	ITA: 1978-80 GRE: 1978-87 IRE: 1978-89 SWE: 1978-92 SPA: 1978-94
Primary surplus	Net lending (+) or net borrowing (-) excluding interest; general government - Excessive deficit procedure Percentage of GDP at market prices (excessive deficit procedure)	UBLGIE	1978-2004
Primary surplus	Net lending (+) or net borrowing (-) excluding interest; general government - Former definition Percentage of GDP at market prices (excessive deficit procedure)	UBLGIF	ITA: 1978-80 GRE: 1978-87 IRE: 1978-89 SWE: 1978-92 SPA: 1978-94
Structural deficit	Cyclically adjusted net lending (+) or net borrowing (-) of general government: Adjustment based on trend GDP. Percentage of GDP at market prices (excessive deficit procedure)	UBLGA	1978-2004
Structural deficit	Cyclically adjusted net lending (+) or net borrowing (-) of general government - Adjustment based on potential GDP - Former definition ; Percentage of GDP at market prices (excessive deficit procedure)	UBLGAP	ITA: 1978-80 GRE: 1978-87 IRE: 1978-89 SWE: 1978-92 SPA: 1978
Structural primary surplus (CAPS)	Cyclical adjustment of public finance variables based on POTENTIAL GDP; Net lending (+) or net borrowing (-) excluding interest of general government adjusted for the cyclical component :- Adjustment based on potential GDP ESA 1995	UBLGBP	1978-2004
Structural primary surplus (CAPS)	Net lending (+) or net borrowing (-) excluding interest of general government adjusted for the cyclical component - Adjustment based on potential GDP - Former definition	UBLGBPF	ITA: 1978-80 GRE: 1978-87 IRE: 1978-89 SWE: 1978-92 SPA: 1978-94
Long term interest rate	Real long term interest rates, deflates GDO	ILRV	1978-2004
Tax rate	Current tax on income and wealth (direct tax): general government. ESA 95	UTYG	1999-2005

The length of our time series is of relatively moderate size. This is a handicap when testing for structural breaks. In order to increase the sample size and to augment the power of time series analysis we are pooling data in seemingly unrelated regressions (SUR). This methodology is also justified by the fact that the error terms are correlated (see Annex 2). We also test for panel unit roots.[14] Our tests all rejected the null of either

[14] Using the routine provided for 5 such tests in E-views (E-views, 2004: 514-525). These procedures are more powerful than the standard multivariable time series procedures testing for unit roots (see Levin et al. 2002).

common or individual unit root processes, although the Hadri test also rejects the null of no unit root in any of the series in the panel (see Annex 3). On balance we therefore accept the assumption of no unit root.

The growth adjusted real interest rate uses the AMECO long term interest rates derived from national government bonds. Deducting the average tax rate on income and wealth (average for 1999-2005) modifies the after-tax growth adjusted real interest rate sometimes significantly (see Table 7 below). The rates vary substantially over time, although, with the exception of Finland, they never exceed 10 percent in the positive or negative range. Standard ADF tests reject unit roots for the (r-y)-series in most cases at the 10 percent level for the time period 1978-2005 (see Annex 4). For the longer period 1961-2005 the probabilities of a unit root is even larger. This is counterintuitive to theory, notably the Keynes-Ramsey rule, which implies a positive stable mean (see Blanchard and Fischer, 1989). A stationary economic environment has often justified the assumption of a deterministic model of dynamic efficiency. Our unit root tests reject this hypothesis. But even if we were to reject the hypothesis of the growth-adjusted real interest rate evolving as a random walk, the usual ad hoc assumption of a fixed macroeconomic environment is clearly not realistic, as time variations are substantive (See also Bohn 2005).

2.2 Responsiveness to the Excessive Deficit Procedure (EDP)

We estimate the policy response to the excessive deficit procedure following the methodology in Collignon and Mundschenk (1999). Individual OLS regressions for each country report the α-coefficients in the first column of Table 3 for each country. Given the relatively small sample of annual observations, we then estimate a SUR (seemingly unrelated regressions) system for all 14 countries. Further SUR for 10 member states of the Euro-area excludes Luxemburg and Greece as Luxemburg's data represent an outlier situation and Greece's data are subject to serious doubts about the coherence of the officially reported statistics. Including a time trend improved the statistical quality of the estimated model, although the time trend was rarely significant at the individual country level. In general, we find that the SUR-14 model is the most efficient, although the estimates for each country show only minor differences.

Table 3. Policy Response to Excessive Deficit Procedure

	Constant			Alpha			Beta			R square		
	MCO	SUR 14	SUR 10	MCO	SUR 14	SUR 10	MCO	SUR 14	SUR 10	MCO	SUR 14	SUR 10
Austia	-1,659	-1,481	-0,452	0,356	0,314	0,2531	-0,039	-0,034	0,001	0,099	0,097	0,088
s.e.	*2,447*	*1,829*	*1,999*	*0,275*	*0,201*	*0,2239*	*0,078*	*0,058*	*0,063*			
Belgium	-5,171	-4,006	-4,673	0,52	0,422	0,4797	-0,006	0,002	-0,002	0,489	0,475	0,487
s.e.	*1,587*	*1,364*	*1,384*	*0,125*	*0,106*	*0,1083*	*0,015*	*0,013*	*0,013*			
Denmark	-0,192	-0,138		0,191	0,179		0,005	0,009		0,155	0,153	
s.e.	*0,865*	*0,73*		*0,121*	*0,081*		*0,023*	*0,016*				
Finland	0,313	1,515	1,087	0,061	-0,039	-0,0385	0,009	0,055	0,043	0,06	0,027	0,037
s.e.	*1,82*	*1,301*	*1,405*	*0,134*	*0,087*	*0,0984*	*0,051*	*0,033*	*0,037*			
France	4,292	2,802	3,63	0,218	0,257	0,237	0,106	0,064	0,088	0,415	0,384	0,408
s.e.	*1,438*	*0,986*	*1,117*	*0,095*	*0,067*	*0,076*	*0,039*	*0,026*	*0,03*			
Germany	1,689	2,145	1,96	0,592	0,609	0,6063	0,043	0,06	0,053	0,513	0,511	0,512
s.e.	*1,418*	*1,203*	*1,238*	*0,128*	*0,106*	*0,11*	*0,049*	*0,042*	*0,043*			
Greece	0,732	-0,825		0,229	0,243		0,018	-0,001	0,019	0,248	0,239	
s.e.	*3,598*	*2,659*		*0,121*	*0,085*		*0,043*	*0,031*	*0,008*			
Ireland	-4,026	-4,544	-3,935	0,356	0,384	0,3497	0,02	0,024	0,019	0,485	0,479	0,485
s.e.	*1,333*	*1,001*	*1,08*	*0,094*	*0,065*	*0,073*	*0,009*	*0,008*	*0,008*			
Italy	-1,73	-2,199	-1,454	0,252	0,291	0,2563	-0,004	-0,008	0,002	0,255	0,251	0,252
s.e.	*1,813*	*1,331*	*1,432*	*0,103*	*0,079*	*0,0835*	*0,025*	*0,018*	*0,019*			
Netherlands	-1,322	-1,709	-1,594	0,454	0,552	0,5244	-0,031	-0,045	-0,04	0,25	0,234	0,243
s.e.	*0,847*	*0,672*	*0,711*	*0,166*	*0,106*	*0,1249*	*0,022*	*0,017*	*0,019*			
Portugal	-2,253	-2,208	-1,757	0,588	0,61	0,5153	-0,049	-0,04	-0,034	0,303	0,301	0,297
s.e.	*1,338*	*0,873*	*0,955*	*0,198*	*0,091*	*0,1129*	*0,042*	*0,028*	*0,032*			
Spain	-1,565	-0,418	-0,014	0,244	0,153	0,1301	-0,023	0,004	0,014	0,132	0,111	0,091
s.e.	*1,653*	*1,098*	*1,283*	*0,163*	*0,106*	*0,1284*	*0,036*	*0,023*	*0,028*			
Sweden	0,293	0,472		0,107	0,148		0,058	0,084		0,201	0,165	
s.e.	*1,376*	*1,158*		*0,125*	*0,089*		*0,051*	*0,037*				
UK	-1,192	-1,212		0,063	0,039		0,146	0,152		0,458	0,456	
s.e.	*0,642*	*0,529*		*0,082*	*0,055*		*0,037*	*0,023*				

We find the R^2 values generally satisfying, except in Austria, Denmark, Finland and Spain. Finland appears to be special case, as it has run budget surpluses in most years (except in the 1990s) and kept very low debt ratio. Consequently, it is not surprising that estimating the correction of excessive deficits is not highly significant in this country. All other estimated alphas have the expected sign and all values are in the range of 20-60 percent. The t-values are acceptable for most alphas (except for Finland and UK). However, the estimated betas are far less informative. Only in France, the Netherlands and in the UK and Sweden, is the value of β significantly different from 0. Thus, contrary to the US-model estimated by Bohn, fiscal policy in Europe seems to be driven by deficit and not by debt considerations. Even the high debt levels in Italy, Belgium and Greece do not seem to have influenced policy makers in these countries. We may conclude that in all Euroland member states, public authorities are responding to a rule similar to the excessive deficit procedure, although the speed, by which they react, varies considerably among countries. The half-life of removing the excessive deficit varies from 1.15 years in Portugal and Germany to over 4.5 years in Spain, with 2.7 years in France and 2.4 years in Italy.

2.3 Responsiveness to the Stability and Growth Pact (SGP)

The Stability and Growth Pact intended to strengthen the commitment to fiscal discipline. For this purpose, it set the rule of balancing structural deficits over the medium term. In other words it set a permanent target of zero for structural budget deficits. Figure 3 shows that this rule is not fully followed, but it may be appropriate to proceed with a gradual adjustment to prevent negative demand shocks caused by excessive consolidation. It this case, there should be a structural α that indicates the structural consolidation efforts and a cyclical α that reflects variations in cyclical deficits. An important criticism against the Stability and Growth Pact is the charge that its rigid rules prevent anti-cyclical stabilization policies or even impose pro-cyclicality (Bayoumi and Eichengreen, 1995; von Hagen and Eichengreen, 1996; Eichengreen and Wyplosz, 1998). Does this hypothesis stand up to the facts? A structural α lager than the growth-adjusted real interest rate would guarantee a sustainable steady state debt position in accordance with SGP. The cyclical α would have a negative sign if the government pursued anticyclical policies and a positive sign if it consolidated and relaxed pro-cyclically. We regress our policy variable on the structural deficit and the cyclically determined component and call the respective responsiveness coefficients, the structural alpha (α_{str}) and m the cyclical alpha (α_{cyc}).

The estimated reaction function is:

$$\Delta s = \alpha_{str.}(structuraldef) + \alpha_{cyc}(cyclicaldeficit) + \beta debt / GDP - z$$

Table 4 gives the results. Out of 14 countries, 8 pursue anti-cyclical policies; two of them (Denmark and the UK) are not members of the Euroarea. Thus, the Eurozone is exactly split in half between pro and anti-cyclical policies. This cannot be interpreted as a systematic bias in favor of procylicality. In some countries, the betas increase in statistical significance when we include cyclical deficits. We do not confirm Briotti's (2004) observation that fiscal policies were more pro-cyclical in high deficit and in large countries. Also, we do not find any systematic correlation of cyclical policies and members states inside or outside the Eurozone. Austria has the most active anti-cyclical policy in Europe. It reacts (even overreacts) very strongly to cyclical deficits, but it also acts to rebalance structural deficits. This behavior seems to be the long shadow of "Austrokeynesianism" (Neck and Haber, 2005).

Italy, France, Greece, Spain and Finland follow similar although less forceful Keynesian behavior. Interestingly, anti-cyclical policies do not contradict consolidating structural deficits. All structural deficit coefficients are positive. Only in Germany, Belgium, the Netherlands and Sweden, and to a lesser degree in Portugal and Ireland governments *consolidate pro-cyclically.* However, this may reflect more the anti-Keynesian ideologies of policy makers, especially in Germany, than constraints imposed by the SGP. The Stability and Growth Pact does not prevent governments from pursuing anti-cyclical policies.

Table 4. Policy response and business cycle

	Constant		Structural alpha		Cyclical alpha		Beta	
	Regression with 14 countries	Regression with 10 countries	Regression with 14 countries	Regression with 10 countries	Regression with 14 countries	Regression with 10 countries	Regression with 14 countries	Regression with 10 countries
Austria	0.018	0.671	0.398	0.384	-1.267	-1.05	0.018	0.029
s.e.	*1.361*	*1.826*	*0.173*	*0.195*	*0.395*	*0.438*	*0.052*	*0.057*
Belgium	-4.333	-4.872	0.448	0.489	0.322	0.488	-0.001	-0.007
s.e.	*1.355*	*1.401*	*0.104*	*0.111*	*0.239*	*0.252*	*0.013*	*0.013*
Denmark	-1.546		0.559		-0.229		-0.015	
s.e.	*0.670*		*0.109*		*0.130*		*0.003*	
Finland	2.342	2.235	0.377	0.204	-0.228	-0.248	0.065	0.059
s.e.	*1.408*	*1.474*	*0.158*	*0.115*	*0.129*	*0.136*	*0.035*	*0.037*
France	5.565	6.379	0.382	0.355	-0.283	-0.227	0.135	0.158
s.e.	*1.068*	*1.311*	*0.067*	*0.082*	*0.132*	*0.18*	*0.028*	*0.034*
Germany	3.132	3.383	0.669	0.680	0.418	0.441	0.093	0.102
s.e.	*1.322*	*1.365*	*0.108*	*0.112*	*0.150*	*0.155*	*0.045*	*0.047*
Greece	0.152		0.415		-0.171		0.046	
s.e.	*1.112*		*0.086*		*0.255*		*0.035*	
Ireland	-5.118	-4.846	0.395	0.388	0.092	0.106	0.03	0.028
s.e.	*1.197*	*1.261*	*0.187*	*0.083*	*0.165*	*0.172*	*0.008*	*0.009*
Italy	-1.466	-1.931	0.339	0.307	-0.733	-0.484	0.010	-0.026
s.e.	*1.260*	*1.475*	*0.074*	*0.080*	*0.277*	*0.309*	*0.018*	*0.016*
Netherlands	-1.893	-1.97	0.792	0.774	0.276	0.333	-0.035	-0.038
s.e.	*0.634*	*0.647*	*0.130*	*0.135*	*0.137*	*0.146*	*0.016*	*0.017*
Portugal	-1.841	-1.305	0.673	0.603	0.188	0.122	0.012	0.011
s.e.	*0.935*	*0.975*	*0.108*	*0.115*	*0.230*	*0.244*	*0.035*	*0.036*
Spain	-0.759	-0.519	0.308	0.267	-0.168	-0.094	-0.010	-0.002
s.e.	*1.117*	*1.319*	*0.128*	*0.150*	*0.175*	*0.217*	*0.024*	*0.028*
Sweden	-1.958		0.422		0147		0.075	
s.e.	*1.338*		*0.122*		*0.161*		*0.037*	
UK	0.167		0.381		-0.114		0.184	
s.e.	*0.589*		*0.087*		*0.142*		*0.02*	

3. Testing for Sustainability

3.1 Structural Breaks

Given our small sample of observations, we have estimated alphas for the full 27-year period and augmented the statistical power of the regressions by pooling the member states of the EU. However, one would expect that the introduction of the euro in 1999 and the accompanying fiscal framework would have changed the policy behavior of governments. We must check, whether there is constancy in the policy parameters.

In order to test for a structural break in the regression equation we divide the data into two sub-periods: the first from 1978 to 1996 and the second from 1997 to 2005. Even if EMU officially only began in 1999, it is reasonable to start the euro-era two years earlier, when qualification for membership was already measured with respect to compliance with the fiscal framework. We calculate alphas for each sub-period and run a Chow test to check if we can detect a structural break in the two respective alphas. However, a panel regression for 14 or even 10 countries with only 8 annual observations precluded a Chow test for the SUR model. We need to reduce the model to at least 7 countries and therefore use OLS for the Chow test regarding the other member states. But which countries should we use for OLS or SUR? We first run a test checking whether the difference between the estimated alphas under the OLS method and the SUR method are statistically significant. In that case we keep the country in the SUR-group. The results are shown in Annex 5.

We then test for structural breaks in our policy reaction function. The test is formulated as:

H0: The coefficients of the regressions are the same in the two sub-periods.

H1: The coefficients of the regression are different from one sub-period to another.

Table 6. Chow Test for Structural Break

	alpha total	alpha 78-97	alpha 97-05	F stat	p-value	
France	0.218	0.201	0.088	0.577	0.423	OLS
Germany	0.592	0.935	0.349	0.713	0.287	
Austria	0.356	0.456	0.747	0.393	0.607	
Denmark	0.191	0.138	1.143	0.562	0.438	
Greece	0.229	0.475	0.741	0.999	0.001	
Italy	0.252	0.084	0.478	0.528	0.472	
UK	0.632	-0.026	0.129	0.47	0.53	
Sweden	0.107	-0.04	0.121	0.825	0.175	
Netherlands	0.5	0.967	0.416	0.787	0.213	SUR
Portugal	0.673	0.744	1.513	0.176	0.824	
Belgium	0.51	0.629	1.764	0.51	0.49	
Finland	-0.003	0.172	0.261	0.356	0.644	
Ireland	0.367	0.358	0.665	0.195	0.805	
Spain	0.109	0.216	-0.056	0.214	0.786	

The results, shown in Table 6, are perfectly clear: *the hypothesis of a structural break is strongly rejected for all countries with the exception of Greece*. In other words, we cannot detect a statistically significant change in the policy coefficient α for the period in which the fiscal framework became binding compared to earlier years. Member states in Euroland seem to behave as they have always behaved: the Stability and Growth Pact makes no difference. Greece is an exception. But here our estimates may be biased by the accounting irregularities, which led to a reassessment of the Greek data after our regressions were calculated. Nevertheless, the change in the Greek α reflects with little doubt a substantial shift toward more stability-oriented policies in the second half of the 1990s and the change from the Papandreou to the Simitis government in 1996 (see Bryant et al. 2001): the cyclically adjusted primary budget improved from -6.7 percent to +5.8 percent in 1998. However, after joining EMU, it has deteriorated again to -1.7 in 2004[15]. It is, therefore, uncertain whether it is the SGP that caused the fiscal consolidation or simply the incentive to join EMU.

Although the results seem clear and strong, one reservation should be mentioned. The Chow test assesses a potential change in all coefficients for the regression equation.[16] It is therefore possible that the alphas in the SUR panel may have changed somewhat individually, but not sufficiently to affect the overall assessment of all coefficients. However, the effect is likely to be minor and this reservation does not put into question the main message: the SGP has not changed the character of member states' fiscal policies.

3.2. Testing for Sustainability

According to proposition 2, a sufficient requirement for fiscal stability is a reaction coefficient $\alpha \geq \alpha_{\min} = r - y$ if $r>y$, and $\alpha \geq \alpha_{\min} = \left(\sqrt{r+\pi} - \sqrt{y+\pi}\right)^2$ if $y>r$. These conditions allow oscillating convergence to the steady state. Faster monotone

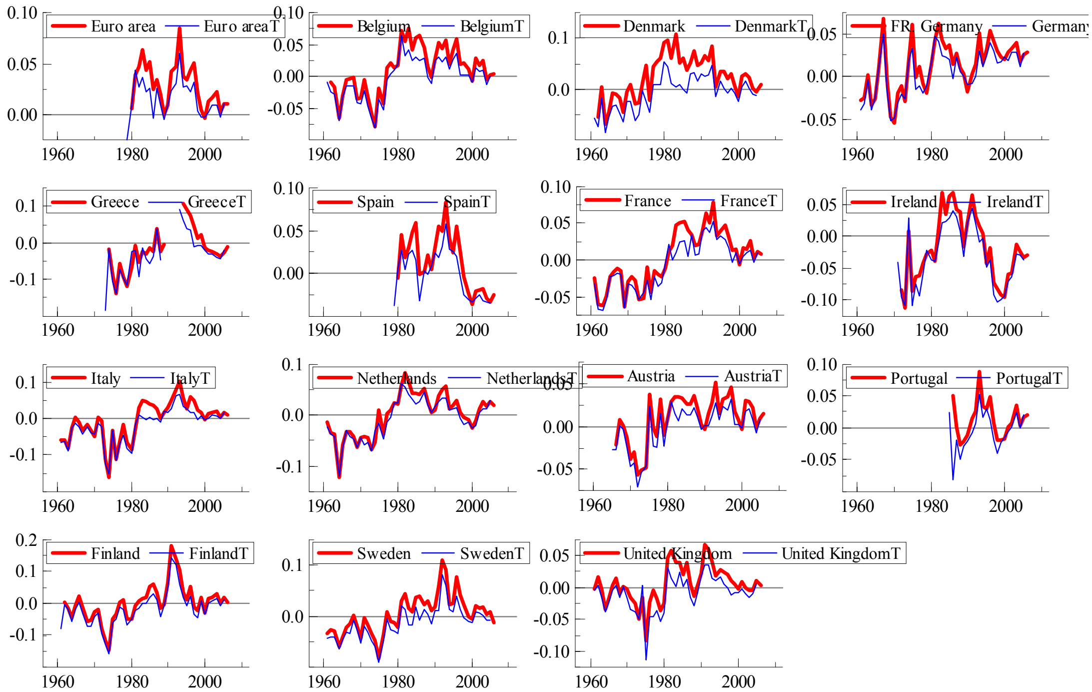
[15] Updated data from AMECO, 2005/6.
[16] This applies also to the constant and therefore excludes the likelihood that member states have changed their implicit deficit target, say from 6 to 3 percent (see Figure 1).

convergence requires $a > a_{cri} = \left(\sqrt{r+\pi} + \sqrt{y+\pi}\right)^2$. We will now look at the empirical evidence.

3.2.1. Sufficient Requirements of Fiscal Sustainability

Figure 4 shows the graph for the growth-adjusted real interest rate before and after tax for selected Euro-area member states. After-tax interest rates matter, as part of the bond holders' revenue is returned to the government through taxes on wealth and income. This reduces the growth adjusted interest rate by the tax share of nominal interest payments, which depends also on inflation. The growth-adjusted interest rate before-tax is: $\mathrm{r - y = (r + \pi) - (y + \pi) = i - g}$. The after-tax rate is $\mathrm{(1 - \tau)i - g = (r - y) - \tau(r + \pi)}$, where τ is the tax rate, and π inflation. i and g are nominal interest and growth rates. Thus an economy with high explicit tax rates on capital income or with high rates of inflation tax will reduce the need for fiscal adjustment.

Figure 4. Growth-Adjusted Real Interest Rates



The bold lines in Figure 4 shows the growth adjusted real interest rate before tax, the finer line after tax. We observe that in the 1960s and 70s growth exceeded interest rates in most countries. This favorable environment turned into its opposite in the 1980 and 90s. Since the beginning of European monetary union growth-adjusted real interest rates have tended to be positive but low. The discrepancy between before and after tax rates, i.e. the impact of taxes and inflation was mainly felt in the high tax Scandinavian countries and in the high inflation period. The variability of these rates is remarkable – a clear signal that the usual ad hoc assumption in the sustainability literature of a fixed and given economic environment is flawed. The range of minimal to maximal values is ± 15 percent around zero. It is largest in Finland, but positive rates never exceed 10 percent in any other country. Figure 4 also reveals that growth-adjusted real interests rate were generally lower after the Euro was introduced than in the 20 years before. This reflects the generally improved economic environment after European monetary policy was centralized in the ECB and risk premia for exchange rate volatitiy disappeared. How can we assess that the sustainability conditions of propositions (1)-

(3) are met? Given that we have a non-neglectable probability that the growth-adjusted interest rate follows a random walk, the most appropriate procedure to compare (r-y) and α would be a test for co-integration for a time-varying α and looking at the co-integrating vector. However, given our small sample and short time series, this is not feasible. We therefore may ignore the unit root argument and compare the estimated α with the means of (r-y) for different time periods.

Table 7. Meeting the Sustainability Condition

$\alpha > \alpha_{\min} = r - y$ **or** $\alpha > \alpha_{aftertax} = r - y - \tau(r + \pi)$

	1978-2005			1978-1996			1997-2005		
	α	$\alpha_{\min}$	$\alpha_{aftertax}$	α	$\alpha_{\min}$	$\alpha_{aftertax}$	α	$\alpha_{\min}$	$\alpha_{aftertax}$
France	0.218	0.019	0.01	0.201	0.025	0.02	0.088	0.007	0.01
Germany	0.592	0.02	0.02	0.935	0.019	0.01	0.349	0.02	0.02
Austria	0.356	0.017	0.01	0.456	0.019	0.01	0.747	0.013	0.01
Denmark	0.191	0.035	0.01	0.138	0.048	0.02	1.143	0.007	0
Greece	0.229	-0.013	-0.02	0.475	-0.01	-0.02	0.741	-0.019	-0.02
Italy	0.252	0.011	0	0.084	0.013	0	0.478	0.007	0.01
UK	0.632	0.011	0	-0.026	0.015	0	0.129	0.002	-0.01
Sweden	0.107	0.018	0	-0.04	0.025	0.01	0.121	0.004	0
Netherlands	0.5	0.021	0.02	0.967	0.033	0.03	0.416	-0.003	0
Portugal	0.673	-0.014	0	0.744	-0.017	0	1.513	-0.007	0
Belgium	0.51	0.027	0.02	0.629	0.036	0.02	1.764	0.006	0
Finland	-0.003	0.018	0.01	0.172	0.028	0.01	0.261	-0.005	0.01
Ireland	0.367	-0.017	0.02	0.358	0.005	0	0.665	-0.064	0.07
Spain	0.109	0.005	0	0.216	0.017	0.01	-0.056	-0.018	0.03

Table 7 compares the estimated alphas with the *average required minimum* ($\alpha_{\min} = r - y$ and $\alpha_{after\ tax} = (1-\tau)i - g$) for the total time period of our regression and for the two sub-periods. It is immediately evident[17] that the sufficient condition for debt sustainability is fulfilled for all countries and all periods. This applies to the average values as well as for the maximum values observable in Figure 4. Hence, even if the SGP has made no difference to the *conduct* of fiscal policy, the *overall fiscal policy orientation* of Euro-member states is sustainable.

However, this comparison is subject to Bohn's (2005) criticism of assuming stability in the macroeconomic environment. It may therefore be safer to simply look whether the

[17] Formal F-tests support the intuition, except in the case of Finland.

estimated α is larger than the maximum value for (r-y), as this allows reasonable fluctuations below the ceiling. Comparing Figure 4 with Table 7 reveals that any α larger than 10 percent guarantees debt sustainability even in the most unfavorable case. This most stringent condition is met by all member states, although there is some doubt for Spain and France after the start of the EMU. Nevertheless, the overall picture is one of sustainable debt in Europe.

3.2.2. Rapid Convergence to the Steady State

While the above results confirm the pre-EMU expectation of debt sustainability by Collignon and Mundschenk (1999), we can now go even further. The formulation of the critical value $a > a_{cri} = \left(\sqrt{r+\pi} + \sqrt{y+\pi}\right)^2$ tells us how fast a government must consolidate its deficit, if the fiscal variables are to converge without periodic oscillations straight to their inter-temporal equilibrium. This is of interest for the short-term assessment of changes in the debt ratio. For if we knew that a country's debt is converging only with oscillations to the steady state but not in a monotonous fashion, the temporary increase in the observed debt ratio would not reflect unsustainable borrowing, although it may violate the Treaty provision of "approaching the reference value at a satisfactory pace" (art. 104c). We may therefore, postulate that countries with a debt ratio exceeding 60 percent should have a critical response to excessive deficits that would allow them to converge monotonously to the steady state.

Table 8. Test for Rapid Convergence: $\alpha > \alpha_{crit} = \left(\sqrt{r+\pi} + \sqrt{y+\pi}\right)^2$

	Total		1978-1996		1997-2005	
	α	α_{crit}	α	α_{crit}	α	α_{crit}
France	0.218	0.287	0.201	0.346	0.088	0.229
Germany	0.592	0.209	0.935	0.248	0.349	0.173
Austria	0.356	0.232	0.456	0.272	0.747	0.178
Denmark	0.191	0.307	0.138	0.37	1.143	0.169
Greece	0.229	0.575	0.475	0.72	0.741	0.126
Italy	0.252	0.401	0.084	0.507	0.478	0.304
UK	0.632	0.332	-0.026	0.387	0.129	0.181
Sweden	0.107	0.322	-0.04	0.392	0.121	0.184
Netherlands	0.5	0.224	0.967	0.246	0.416	0.176

Portugal	0.673	0.52	0.744	0.671	1.513	0.149
Belgium	0.51	0.256	0.629	0.297	1.764	0.168
Finland	-0.003	0.325	0.172	0.399	0.261	0.201
Ireland	0.367	0.396	0.358	0.44	0.665	0.161
Spain	0.109	0.405	0.216	0.488	-0.056	0.27

Table 8 shows the relevant critical alphas next to the actual policy coefficients. Given that the pre-tax rate is the tougher condition to meet, we only show the critical alphas for these interest rates. We find that the change in economic environment following the creation of European Monetary Union has lowered the critical values everywhere and thereby accelerated the convergence to the steady state. Given that $\alpha_{crit} = \left(\sqrt{r+\pi} + \sqrt{y+\pi}\right)^2$, this must clearly be a result of lower interest rates under the ECB-led monetary policy as inflation is historically low and growth is not impressive. While in the pre-euro period only 6 countries responded to excessive deficits with a higher coefficient than was critically necessary for rapid convergence, their number has increased to 10 after EMU started. Only Spain and France within Euroland, and Sweden and Denmark outside, respond so slowly to the fiscal rules that the debt-ratio and the primary surplus only converge with periodic oscillations to their intertemporal equilibrium. Yet, none of these countries have a debt ratio far above 60 percent. This is an important result with respect to France. We noticed in Table 1 that the actual debt ratio there was 66.7% in 2006, while the steady state is 62.1%. Table 8 shows that French fiscal policy has responded less vigorously to excessive deficits after the start of EMU than would have been necessary for a monotonous convergence, while Table 7 showed that the reaction was sufficient to ensure debt sustainability (given the low growth-adjusted real interest rate). Thus, the rise in the French debt ratio witnessed in Figure 2 must represent the oscillating overshoot in the debt dynamics over the equilibrium. Unless fiscal policy behavior has structurally changed (for which we have no evidence), the French debt ratio will fall again the future and gravitate to 62% unless the economic environment changes.

In general, we may conclude that Europe's fiscal position has become more stable since European Monetary Union started. But the surprising evidence is that this improved fiscal sustainability is not due to the Stability and Growth Pact imposing more stringent rules on governments; it is explained by a monetary policy framework, which has allowed significantly lower real interest rates by reducing risk premium for exchange rate uncertainty and lower inflation volatility.

The interaction between the macroeconomic environment and fiscal policy can be shown in a graph. It uses Pasinetti's (2000) idea of plotting equation (2) into a two-dimensional space. But contrary to his graphs, Figure 5 draws the equilibrium line at which the primary surplus is equal to the debt service into the fiscal policy – economic environment space. The equilibrium line is determined as s*=d(r-y), so that the slope of the line depends on the debt ratio d_t in a given economy. For high-debt countries it is steep (1 for a debt/GDP ratio of 100%), for low debt countries it is flat. The (weak) sustainability area consists then of the set of all pairs [s, (r-y)] above the equilibrium line. A fiscal policy consolidation is represented by a move upward, an improvement in the macroeconomic environment by a move leftward. We have so far assumed exogeneity between the economic environment and fiscal policy. Figure 5 gives some indication about their interaction.

Figure 5. Sustainability and macroeconomic environment: Euroland

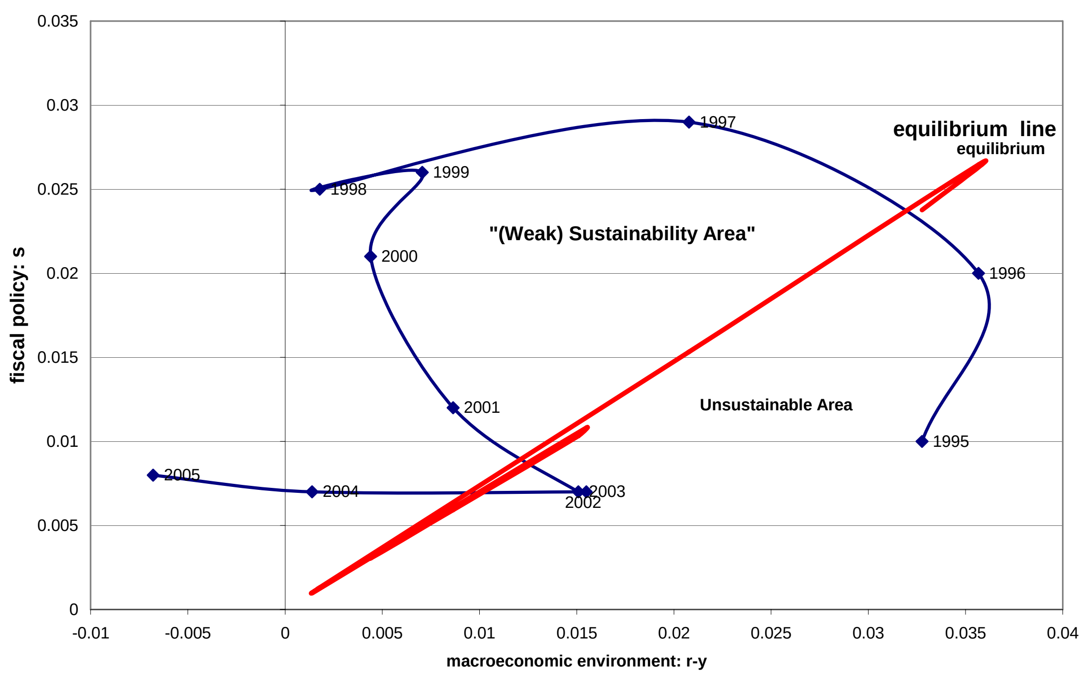


Figure 5 shows the actual realizations of Euroland's aggregate fiscal position[18]. In the mid-1990s, the fiscal policy stance was not sustainable and required fiscal consolidation. When most EU member states took action and the realization of EMU became credible, interest rates fell, growth resumed and fiscal policy became sustainable. Thus, the realization points wander first upwards and then leftwards. Fiscal consolidation to assure debt sustainability seems to be growth opportunity. After European monetary union started in 1999, fiscal fatigue led to a reduction in the cyclically adjusted primary budget positions of Euroland (move down), although the environment remained broadly supportive, only when the debt ratio increases in 2002 and 2003 Euroland's debt becomes weakly unsustainable, is the macroeconomic environment clearly deteriorating. In recent years, the economic environment has exogenously improved, while the fiscal policy behavior is back to where it was in the mid-1990s. But the improved environment assures sustainability. Thus, Figure 5 confirms for the Euroland aggregate, what individual country analysis has already indicated: Euroland's public finances are sustainable in today's favorable environment, but fiscal policy behavior by member states has not changed. One may wonder whether Europe's institutional fiscal framework is optimal. But this observation does not invalidate the need for fiscal policy rules. In fact, what our analysis has shown is that debt sustainability without fiscal rules is not very likely.

[18] Data from AMECO, 2005/6

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Annex 1. Proof of Proposition 1 and 2 (with Antoine Nebout)

For the proof, we solve the system of differential equations:

$$\begin{cases} d' = (r-y) - s \\ s' = (\alpha(r+\pi)+\beta)d - \alpha s - z \end{cases}$$

The characteristic equation of the homogeneous system is:

$$\lambda^2 + (\alpha - (r-y))\lambda + \alpha(y+\pi) + \beta = 0$$

We obtain the determinant of the second order equation:

$$\Delta = (\alpha - (r-y))^2 - 4(\alpha(y+\pi)+\beta)$$

The solutions of this second order equation are

$$\lambda_{1,2} = \underbrace{-\frac{\alpha-(r-y)}{2}}_{\text{h}} \pm \sqrt{\frac{\alpha-(r-y)^2}{4} - (\alpha(\mathrm{y}+\pi)+\beta)}$$

The determinant will give us (i) the conditions of convergence with dampened oscillations (the pseudo-periodic case); (ii) the conditions for fast and monotonous convergence to the equilibrium; (iii) critical values for alpha establishing the minima conditions for stability and for monotonous convergence. We will take the economic environment *(r-y)* as exogenously given and focus on the policy reaction parameter *α* and *β*. To simplify the mathematics, we focus on the two polar cases (1) α=0, β>0 and (2) α>0, β=0. Empirically, the second case is more relevant, as β is statistically often not significant.

For the formal proof of this proposition, we solve the determinant of the homogenous system under three assumptions: (i) $\Delta < 0$, (ii) $\Delta > 0$, (iii) $\Delta = 0$.

(i). $\Delta < 0$ **: Pseudo-periodic case**

A sufficient and necessary condition on α et β for Δ to be negative implies:

$\Delta < 0 \Leftrightarrow (\alpha - (r-y))^2 < 4(\alpha(y+\pi) + \beta$

$$\Leftrightarrow \alpha(\alpha - 2(r+y-2\pi)) - \beta < -(r-y)^2$$

Assuming β=0, which is justified on empirical grounds:

$\Delta < 0 \Leftrightarrow f(\alpha) = \alpha^2 - 2\alpha A + B^2 \le 0,$ with $A = r + y + 2\pi$ and $B = (r-y)^2$

To determine the interval of the αs for which the parabolic function $f(\alpha) < 0$, we determine the two roots by computing the discriminator of $f(\alpha) = 0$:

$\Delta = A^2 - B^2 = (A-B)(A+B) = 4(r+\pi)(y+\pi)$

And we obtain the two characteristic roots:

$$\Rightarrow \begin{cases} \alpha_1 = r + y + 2\pi - 2\sqrt{(r+\pi)(y+\pi)} = (\sqrt{r+\pi} - \sqrt{y+\pi})^2 \\ \alpha_2 = r + y + 2\pi + 2\sqrt{(r+\pi)(y+\pi)} = (\sqrt{r+\pi} + \sqrt{y+\pi})^2 \end{cases}$$

Thus, the range of alphas, which are compatible with sustainability $f(\alpha) = \alpha^2 - 2\alpha A + B^2$ are such that the *sufficient and necessary condition* for Δ to be negative is: $\alpha \in [\alpha_1, \alpha_2]$.

A *necessary condition for the solution to be stable* is:.

Combining the two conditions we obtain:

If $\alpha_1 < r - y \Rightarrow \alpha \in [r-y, \alpha_2]$

If $\alpha_1 > r - y \Rightarrow \alpha \in [\alpha_1, \alpha_2]$

The first case is equivalent to:

$r + y + 2\pi - 2\sqrt{(r+\pi)(y+\pi)} < r - y \Leftrightarrow 2(y+\pi) < 2\sqrt{(r+\pi)(y+\pi)} \Leftrightarrow y < r$

So if $\begin{matrix} y < r \Rightarrow \alpha \in [r-y, \alpha_2] \\ y > r \Rightarrow \alpha \in [\alpha_1, \alpha_2] \end{matrix}$

In this case $\alpha \in [r\text{-}y, \alpha_2]$ or $[\alpha_1, \alpha_2]$.

Thus, either way, if $\alpha > r - y$, the system is converging to the steady state. If the system is dynamically efficient from the Keynes-Ramsey Golden Rule point of view, i.e. if $y < r$, then the lower bound for ensuring debt sustainability is $r - y$; if the system is dynamically inefficient in the Keynes-Ramsey sense ($y > r$), the lower bound is $\alpha_1 = (\sqrt{r+\pi} - \sqrt{y+\pi})^2 > r - y$, which means that high economic growth allows governments more leeway in consolidation.

The general solution of the system yields for the debt ratio:

$$d(t) = e^{ht}(m_1 \cos vt + im_1 \sin vt) + \overline{d}$$

Where $h = -\dfrac{\alpha - (r-y)}{2}$ and $v = \sqrt{\dfrac{\alpha - (r-y)^2}{4} - (\alpha(\mathrm{y}+\pi)+\beta)}$

The initial condition $d(0) = d_0$ gives us $m_1 = d_0 - \overline{d}$

If we take only the real part of the solution we get the time path:

$$d(t) = e^{ht}((d_0 - \overline{d})\cos vt) + \overline{d}$$

(ii). $\Delta > 0$ **: Monotonic convergence (if** $\alpha > \alpha_2$ **)**

For $\alpha < \alpha_1$ the system is unstable, and we will not examine this case.

In the case of $\Delta > 0$ and $\alpha > \alpha_2$**,** we have again the characteristic roots:

$$\lambda_{1,2} = \underbrace{-\frac{\alpha - (r-y)}{2}}_{\mathrm{h}} \pm \sqrt{\frac{\alpha - (r-y)^2}{4} - (\alpha(\mathrm{y}+\pi)+\beta)}$$

In this case the condition for convergence to the steady state is for both eigenvalues to be negative. Hence, a sufficient condition is:

$$\begin{cases} \alpha > r - y \\ \alpha(y+\pi) + \beta \geq 0 \end{cases}$$

And the general solution will be:

$$\begin{cases} d = m_1(e^{\lambda_1 t} + e^{\lambda_2 t}) + \overline{d} \\ s = n_1(e^{\lambda_1 t} + e^{\lambda_2 t}) + \overline{s} \end{cases}$$

The initial condition $d(0) = d_0$ gives us $m_1 = d_0 - \overline{d}$

Assuming $\lambda_1 < \lambda_2$ we obtain:

$$d(t) = \left[(d_0 - \overline{d})e^{(h-v)t}\left(1 + e^{2vt}\right)\right] + \overline{d}$$

Thus, if $\alpha > \alpha_2$ we have fast monotonous convergence to the steady state.

(iii). $\Delta = 0$**. Critical case (if** $\alpha = \alpha_1$ **or** α_2**)**

If $\alpha = \alpha_2$, the solution to the characteristic equation is:

$$\lambda = \lambda_1 = \lambda_2 = -\frac{\alpha - (r - y)}{2}$$

So a *sufficient condition* for steady state is:

$\alpha > r - y$.

And the form of the solution is:

$$\begin{cases} d = m_1(1+t)e^{\lambda t} + \bar{d} \\ s = n_1(1+t)e^{\lambda t} + \bar{s} \end{cases}$$

And the time path is: $d(t) = \left[(d_0 - \bar{d})(1+t)e^{ht}\right] + \bar{d}$

In analogy to physics, this case is named the aperiodic state and the convergence is quite fast – in any case much faster than in the periodic case.

Annex 2. Variance-covariance matrix for 10 SUR countries

	France	Nether-lands	Portugal	Germany	Belgium	Austria	Finland	Italy	Ireland	Spain
France	1									
Netherlands	-0.0381	1								
Portugal	-0.1698	-0.3789	1							
Germany	-0.2212	-0.0341	-0.0896	1						
Belgium	0.0332	0.0503	-0.1624	0.1966	1					
Austria	0.1533	-0.0641	0.1239	-0.0403	0.0456	1				
Finland	-0.4241	0.0604	0.1302	0.0002	-0.1365	0.2109	1			
Italy	0.0345	0.2359	0.314	0.104	0.2112	-0.0492	-0.2603	1		
Ireland	-0.0441	0.2151	0.248	-1251	-0.1212	-0.2304	0.2654	0.1889	1	
Spain	0.3591	-0.0974	0.3272	-0.0139	-0.1339	0.1699	-0.3266	0.0757	-0.099	1

Annex 3. Group unit root test: Summary

Sample: 1978 2005
Series: FST, FDF, DFDT, NST, NDF, DNDT, PST, PDF, DPDT, GEST, GEDF, DGEDT, BST, BDF, DBDT, DST, DDF, DDDT, AST, ADF, DADT, FIST, FIDF, DFIDT, UKST, UKDF, DUKDT, ITST, ITDF, DITDT, GST, GDF, DGDT, IRST, IRDF, DIRDT, SST, SDF, DSDT, EST, EDF, DEDT
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic selection of lags based on SIC: 0 to 6
Newey-West bandwidth selection using Bartlett kernel

Method	Statistic	Prob.**	Cross-sections
Null: Unit root (assumes common unit root process)			
Levin, Lin & Chu t*	-3.52961	0.0002	42
Breitung t-stat	-4.08872	0.0000	42
Null: Unit root (assumes individual unit root process)			
Im, Pesaran and Shin W-stat	-5.48488	0.0000	42
ADF - Fisher Chi-square	166.933	0.0000	42
PP - Fisher Chi-square	133.417	0.0005	42
Null: No unit root (assumes common unit root process)			
Hadri Z-stat	10.2515	0.0000	42

** Probabilities for Fisher tests are computed using an asympotic Chi -square distribution. All other tests assume asymptotic normality.

Annex 4. Unit root test: Summary for growth adjusted real interest rates (before tax)

Unit root tests on (r-y): Null series has unit root

1) ADF-TEST: Null hypothesis is (r-y)

Country	ADF- t-statistics	Probability	Exogenous	Sample
Austria	-4.07267	0.0043	constant	1979-2004
Belgium	-3.817563	0.0318	constant, linear trend	1979-2004
Denmark	-3.669881	0.043	constant, linear trend	1979-2004
Euro-Area	-3.504335	0.0607	constant, linear trend	1980-2004
Finland	-2.809729	0.2069	constant, linear trend	1980-2004
Finland	-3.425557	0.0914	constant, linear trend	1980-1992
France	-2.826434	0.0684	constant	1979-2004
Germany	-3.30399	0.0251	constant	1979-2004
Greece	-3.475006	0.0195	constant	1979-2004
Ireland	-2.345504	0.397	constant, linear trend	1979-2004
Italy	-1.981201	0.2927	constant	1979-2004
Netherlands	-3.46955	0.0649	constant, linear trend	1980-2004
Portugal	-2.96098	0.057	constant	1986-2004
Spain	-3.447542	0.0286	constant	1980-2004
Sweden	-2.881317	0.0613	constant	1979-2004
UK	-2.854526	0.0647	constant	1979-2004

2) KPSS Test: Null series is stationary

Country	Exogenous		LM-Stat.
Ireland	constant	Kwiatkowski-Phillips-Schmidt-Shin test statistic	0.472270
		Asymptotic critical values*: 1% level	0.739000
		5% level	0.463000
		10% level	0.347000
Italy	constant, linear trend	Kwiatkowski-Phillips-Schmidt-Shin test statistic	0.132885
		Asymptotic critical values*: 1% level	0.216000
		5% level	0.146000
		10% level	0.119000
Finland	constant, linear trend	Kwiatkowski-Phillips-Schmidt-Shin test statistic	0.145487
		Asymptotic critical values*: 1% level	0.216000
		5% level	0.146000
		10% level	0.119000

Annex 5. Chow test for the Significance of Differences in α-estimates under OLS and SUR.

If the estimated difference between alphas obtained from OLS and SUR in Table 3 are statistically not significant, it is defendable to use OLS for their estimation.

The tested hypothesis is:

Ho: $\alpha_{SUR} \neq \alpha_{OLS}$

H1: $\alpha_{SUR} = \alpha_{OLS}$

Chow Test for OLS versus Seemingly Unrelated Regressions

	α_{SUR14}	α_{OLS}	F stat	p-value
France	0.218	0.237	0.855	0.145
Germany	0.592	0.606	0.914	0.086
Austria	0.356	0.311	0.8692	0.1308
Denmark	0.191	0.179	0.9187	0.0813
Greece	0.229	0.243	0.911	0.089
Italy	0.252	0.256	0.97	0.03
UK	0.063	0.039	0.771	0.229
Sweden	0.107	0.148	0.751	0.249
Netherlands	0.454	0.524	0.68	0.32
Portugal	0.588	0.515	0.712	0.288
Belgium	0.51	0.48	0.7463	0.2537
Finland	0.061	-0.0385	0.464	0.536
Ireland	0.356	0.384	0.776	0.224
Spain	0.244	0.138	0.521	0.479

The Table gives the F-test. The likelihood that OLS estimates produce results different from SUR is clearly lower for Italy, Greece, Denmark and Germany, but also for France and Austria. We cannot reject it for the other countries. However, given that the UK and Sweden, as non-Euro countries, are not subject to the stringent rules of the SGP, they are also excluded from the reduced SUR model. This leaves The Netherlands, Portugal, Belgium, Finland, Ireland and Spain in the SUR panel. For these 6 countries, we will run a Chow test on SUR, for the others on OLS.

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