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FISCAL DEFICITS, SEIGNIORAGE AND EXTERNAL DEBT: THE CASE OF GREECE

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ABSTRACT

Fiscal Deficits, Seigniorage and External Debt: The Case of Greece*

This paper investigates the relation between the rise in external debt and fiscal developments in Greece. We use an intertemporal model of optimal private-sector savings to argue that stabilization of the public debt/GDP ratio will be sufficient to stabilize the external debt/GDP ratio as well. Our results suggest that stabilization of the public debt/ GDP ratio at a given level through higher taxation will result in a higher external debt/GDP ratio than stabilization at the same level through a reduction in (non-interest) government expenditure. They also suggest that in the case of Greece there is no further scope for a steady-state increase in seigniorage revenue. In fact, the inflation rate slightly exceeds the seigniorage-maximizing rate. We calculate that if the public sector debt were to be stabilized at its current level of approximately 100% of GDP, the primary deficit (i.e., the deficit excluding interest payments) would have to fall to 0.3% of GDP from its projected ratio of 6.5% in 1990 and 5.1% in 1991.

JEL classification: 320, 120, 431
Keywords: public and external deficits and debts, inflation, seigniorage, stabilization, Greece

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NON-TECHNICAL SUMMARY

One of the most significant developments of the 1980s in Greece appears to have been the spectacular rise of external debt. External debt rose from $5.1 billion in 1979 (13% of GNP) to $20.6 billion ten years later (40% of GNP). Debt servicing as a percentage of current receipts from abroad has also more than tripled. It was 8% in 1979 and reached 24% in 1988. In addition, while for the rest of the OECD the 1980s have been a decade of disinflation, average consumer-price inflation in Greece rose from 12.3% in the 1970s to 19.6% in the 1980s.

The 1980s have also witnessed a significant rise in the share of the public sector in Greece, a rise that has been accompanied by persistently high budget deficits and a rapid build-up of public debt. Public-sector debt rose from 27.4% of GDP in 1979 to 91.5% in 1988. The estimates for 1989 put it at more than 100% of GDP. At the same time, total government expenditure rose from 17% of GDP in 1979 to 49.4% in 1988.

This paper investigates the relation between the rise in external indebtedness and these fiscal developments. We also look at the appropriate policies for stabilizing the external debt/GDP ratio, and we ask in particular whether the stabilization of the public debt/GDP ratio is a sufficient condition for the stabilization of the external debt ratio. Furthermore, we look at the pros and cons of alternative ways of stabilizing the public debt/GDP ratio and investigate whether a further rise in inflation in Greece will help this process. We also look briefly at the costs and benefits of joining the process of European monetary unification.

The paper focuses firmly on the medium-run implications of fiscal deficits for external debt and inflation. In the context of Greece we look at both the pattern of developments in the 1980s and at the implications of the various options for stabilizing the ratios of public and external debt to GDP.

The model we use to address these questions is one of optimal private-sector savings, in which private households are forward-looking. This type of model is being increasingly used in both open-economy macroeconomics and public economics, as it recognizes the role of intertemporal private-sector responses to fiscal policy, something ignored by more traditional Keynesian models. We argue that if the private sector is forward-looking in its savings behaviour, stabilization of the public debt/GDP ratio will be sufficient also to stabilize the external debt/GDP ratio. The reason is that the private sector, through its consumption pattern, stabilizes the ratio of its own total assets to GDP.

The authorities of a country in which the ratio of public debt/GDP is rising, as in Greece, have three options in trying to stabilize it at its current level. First, to reduce government expenditure on goods and services; second, to increase tax receipts; and third, to increase revenues from money creation, i.e., seigniorage. The last would substitute money finance for debt finance.

Our theoretical results suggest that stabilization of the public debt/GDP ratio at a given level through higher taxation will result in a higher external debt/GDP ratio than stabilization at the same level through a reduction in (non-interest) government expenditure. The same also applies to seigniorage. Public debt stabilization at a given level through higher seigniorage (monetary growth) will result in a lower external debt than if public debt were to be stabilized through higher taxation. Tax increases result in higher external debt than expenditure reductions because for given pre-tax household income, higher steady-state taxation reduces disposable private-sector income, thus causing a reduction in both private consumption and real household assets. For a given stock of government bonds, a reduction in private-sector assets requires a reduction in the stock of assets other than bonds, say money and foreign assets. Such effects do not arise if the government reduces government expenditure instead of raising taxes. On the other hand, a rise in steady-state seigniorage revenue reduces real-money balances, through a rise in expected inflation and nominal interest rates. As a consequence, there is less of a reduction in the holdings of foreign assets by the private sector than in the case where the same revenue was raised by increased taxes.

We calibrate the model and provide alternative numerical estimates of the rise in taxes and reductions in government expenditure that would be required for stabilization of the public debt/GDP ratio at its 1989 level of approximately 100%. We also calculate the implications for external debt.

Our results suggest that in the case of Greece there is no further scope for an increase in seigniorage revenue. At the 1989-90 inflation rates of 20%, seigniorage as a percentage of GDP is already at its maximum. In fact, the inflation rate slightly exceeds the seigniorage-maximizing rate, so a reduction in steady-state inflation would be called for on seigniorage-maximization grounds. We calculate that if the public-sector debt were to be stabilized at its current level of approximately 100% of GDP, the primary deficit (i.e. the deficit excluding interest payments) will have to fall to 0.3% of GDP from its projected ratio of 6.5% in 1990 and 5.1% in 1991. This assumes GDP growth rates of 2% per annum, inflation rates of 20% and 5% world real interest rates, numbers that are roughly in line with projections for the next two years in the June 1990 OECD *Economic Outlook*. These calculations show the order of the task facing the Greek authorities. They need to reduce the primary deficit by a further 5.5 percentage points of GDP per annum, in addition to the reductions envisaged in the plans prepared by the new government.

If Greece were to enter the exchange rate mechanism (ERM) of the EMS, and therefore adopt a steady-state inflation rate of approximately 5%, stabilization of public and external debt would require a primary surplus of 0.6% of GDP on the same assumptions. Thus, the seigniorage revenue loss associated with ERM membership would require a further reduction in the primary deficit of about one percentage point of GDP. This appears to us a small price to pay for the credibility and other gains that will be associated with a more stable monetary policy and exchange rates in the EMS.

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One of the most significant developments of the 1980s in Greece appears to have been the spectacular rise of external debt. External debt rose from $ 5.1 billion in 1979 (13% of GNP) to $ 20.6 billion ten years later (40% of GNP). Debt servicing as a percentage of current receipts from abroad has also more than tripled. It was 8% in 1979 and reached 24% in 1988. In addition, while for the rest of the OECD the 1980s have been a decade of disinflation, average consumer price inflation in Greece rose from 12.3% in the 1970s, to 19.6% in the 1980s.

The 1980s have also witnessed a significant rise in the share of the public sector in Greece, a rise which has been accompanied by persistently high budget deficits and a rapid buildup of public debt. Public sector debt rose from 27.4% of GDP in 1979 to 91.5% in 1988. The estimates for 1989 put it at more than 100% of GDP. At the same time, total government expenditure rose from 17% of GDP in 1979 to 49.4% in 1988.

What is the relation between the rise in external indebtedness and these fiscal developments? What are the appropriate policies for stabilizing the external debt to

GDP ratio? In particular, is the stabilization of the public debt to GDP ratio a sufficient condition for the stabilization of the external debt ratio, or are additional policy measures required? In other words, is the external constraint just the flip side of the government solvency constraint? What are the pros and cons of alternative ways of stabilizing the public debt ratio? Is a further rise in inflation in Greece going to help this process? What are the costs and benefits of joining the process of European Monetary Unification?

The purpose of this paper is to investigate these questions. The focus is firmly on the medium run implications of fiscal deficits for external debt and inflation. In the context of Greece we look at both the pattern of developments in the 1980s, and at the implications of the various options for stabilizing the ratios of public and external debt to GDP.

The model we use to address these questions is one of optimal private sector savings, in which private households are forward looking. This type of model is being increasingly used in both open economy macroeconomics and public economics, as it recognizes the role of intertemporal private sector responses to fiscal policy, something ignored by more traditional keynesian models.[1]

The first question we seek to answer is whether the stabilization of the ratio of public debt to GDP is a sufficient condition for the stabilization of the external debt to GDP ratio. Additional questions relate to the implications for external debt of alternative ways of stabilizing the public debt to GDP ratio.

We argue that, if the private sector is forward looking in its savings behaviour, stabilization of the public debt to GDP ratio will be sufficient to stabilize the external debt to GDP ratio as well. The reason is that the private sector, through its

[1]Intertemporal models of private sector savings and investment have gone a long way towards replacing keynesian IS–LM models in the open economy macroeconomics literature. The latter are not well suited to the consistent analysis of intertemporal aspects of fiscal policies. In the context of the explanation of current account and external debt behaviour one of the early papers in this mold was Sachs (1981). A large number of papers in the last ten years have utilized this approach, and the books by Bruno and Sachs (1985) and Frenkel and Razin (1987) have popularized it even further.

consumption pattern, stabilizes the ratio of its own assets to GDP.[2]

The authorities of a country in which the ratio of public debt to GDP is rising, like in Greece, have three options in trying to stabilize it at its current level. The first is to reduce government expenditure on goods and services, the second is to increase tax receipts, and the third is to increase revenues from money creation, i.e seigniorage. The latter would substitute money finance for debt finance.

Our theoretical results suggest that stabilization of the public debt to GDP ratio at a given level through higher taxation, will result in a higher external debt/GDP ratio than stabilization at the same level through a reduction in (non–interest) government expenditure. The same also applies to seigniorage. Public debt stabilization at a given level through higher seigniorage (monetary growth) will result in a lower external debt than if public debt were to be stabilized through higher taxation. The reason why tax increases result in higher external debt than expenditure reductions is that, for given pre–tax household income, higher steady state taxation reduces disposable private sector income, thus causing a reduction in both private consumption and real household assets. For a given stock of government bonds, a reduction in private sector assets requires a reduction in the stock of assets other than bonds, say money and foreign assets. Such effects do not arise if the government were to reduce government expenditure instead of raising taxes. On the other hand, a rise in steady state seigniorage revenue reduces real money balances, through a rise in expected inflation and nominal interest rates. As a consequence, there is less of a reduction in the holdings of foreign assets by the private sector than in the case where the same revenue was raised by increased taxes.

We calibrate the model and provide alternative numerical estimates of the rise in taxes and reductions in government expenditure that would be required for stabilization

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[2]Note the difference between our model and Currie and Levine (1991). In their model, because the private sector is not modelled as choosing savings in an intertemporally optimal way (this could be due to credit constraints and other imperfections), the external constraint is distinct from the government solvency constraint. Yet, even in their model, provided there is a sufficiently high wealth elasticity of aggregate demand, private assets can be stabilized.

of the public debt to GDP ratio at its 1989 level of approximately 100%. We also calculate the implications for external debt.[3]

Our results suggest that in the case of Greece there is no further scope for an increase in seigniorage revenue. At the 1989-90 inflation rates of 20%, seigniorage as a percentage of GDP is already at its maximum. In fact, the inflation rate slightly exceeds the seigniorage maximizing rate, so, if anything, a reduction in steady state inflation would be called for on seigniorage maximization grounds. We calculate that if the public sector debt were to be stabilized at its current level of approximately 100% of GDP, the primary deficit (i.e the deficit excluding interest payments) will have to fall to 0.3% of GDP from its projected ratio of 6.5% in 1990 and 5.1% in 1991. This assumes GDP growth rates of 2% per annum, inflation rates of 20% and 5% world real interest rates, numbers which are roughly in line with projections for the next two years in the June 1990 OECD *Economic Outlook*. These calculations show the order of the task facing the Greek authorities. They need to reduce the primary deficit by a further 5.5 percentage points of GDP per annum, in addition to the reductions envisaged in the plans prepared by the new government.

If Greece were to enter the exchange rate mechanism (ERM) of the EMS, and therefore adopt a steady state inflation rate of approximately 5%, stabilization of public and external debt will require a primary surplus of 0.6% of GDP on the same assumptions. Thus, the seigniorage revenue loss associated with ERM membership will roughly require a further reduction in the primary deficit of about one percentage point of GDP. This appears to us a small price to pay for the credibility and other gains that will be associated with a more stable monetary policy and exchange rates in the EMS

[3]Our focus here is entirely on the long run, and the dynamics of adjustment of consumption and debt. We abstract from problems of short run adjustment on the supply side, such as wage, price and employment dynamics. For a model that incorporates such features see Alogoskoufis (1989, 1990). See also Christodoulakis (1990), for an analysis of debt dynamics in a more traditional keynesian open economy model, and Papademos (1990) for an analysis of issues relating to debt and wage price dynamics in a model with a detailed financial sector.

(see Giavazzi and Giovannini 1989).[4]

The rest of the paper is as follows: In section I we examine macroeconomic developments in Greece in the last decade. We point to the fall in the average GDP growth rate, the rise in inflation and the unprecedented rise of the public sector and its deficits. The upshot has been a spectacular rise in public and external debt. In section II we examine a simple medium run model of deficits and debts to examine the relation between public and external deficits and debts. In sections III and IV we present a theoretical investigation of alternative methods for stabilizing a rising public debt to GDP ratio, and their implications for external debt and inflation. In section V we turn to a detailed numerical investigation of the options for Greece by calibrating the model. We also examine the prospects for Greece in the context of monetary union in Europe. Section VI contains conclusions.

I. MACROECONOMIC DEVELOPMENTS IN GREECE IN THE 1980s

In this section we briefly review macroeconomic developments in Greece in the last decade. The performance of the economy in this decade has been rather disappointing in most respects. Some comparative data are presented in Table 1.

As can be seen from Table 1, the performance of the economy of Greece in the 1980s has been much worse than in the 1970s. The average growth rate of GDP fell from 5.4% to 1.5%, average inflation rose to 19.5% from 12.3%, and the current account deficit deteriorated as a percentage of GDP. In addition, the average unemployment

[4]Note, however, that our results indicate that the reduction in inflation brought about by EMS membership will, *ceteris paribus*, require a higher steady state external debt to GDP ratio than otherwise. This could be higher by as much as 22 percentage points of GDP if the lost seigniorage revenue was replaced by a rise in other taxes (Table 6). This is an illustration of the public finance arguments put forward by Dornbusch (1988) in his advocation of a two tier EMS, with "underdeveloped" countries like Greece following a crawling peg exchange rate rule, that would allow them to choose their inflation rate. We do not feel that a loss of seigniorage equal to 1% of GDP is sufficient reason for sticking with high inflation. After all, Greece was a successful member of the Bretton Woods system of fixed exchange rates for 20 years, and its inflation rate was as low as the OECD average, if not lower.

rate almost tripled, and the growth rate of business fixed investment has been negative. During the 1980s, the average growth rate of GDP fell below that of the OECD and the EEC, for the first extended period since the end of World War II. The average inflation rate has been almost three times as high as in the OECD and the EEC, and average unemployment has risen more steeply than in the other OECD and EEC economies.

However, the most spectacular deterioration has been in Greece's external position (Table 2). Total external debt has risen from about $5 billion in 1979 (13% of GNP) to about $20 billion in 1988 (40% of GDP). Debt servicing in 1988 required 24% of current foreign exchange receipts, three times the fraction of 1979. The situation in 1989 and 1990 may have deteriorated a lot more, as the stabilization programme of 1985–87 that slowed down the rise in external indebtedness was abandoned in 1988.

The rise in external indebtedness has gone hand in hand with a sharp deterioration in public finances (Table 3). The public sector borrowing requirement (PSBR) which was equal to 5.7% of GDP in 1979, remained persistently above 12% throughout the 1980s. The election years of 1981, 1985 and 1989 seem to have been crucial in this process, as the PSBR to GDP ratio peaked at elections.

The rise to 14.3% in 1981 was unprecedented. This was in the depth of the recession, and coincided with world real interest rates climbing to record levels. External debt rose by five percentage points of GDP in that year alone. Yet, the spending spree and the deferral of taxes did not help the conservative government, and the socialists won power in a virtual landslide. The PSBR was reduced very little as a percent of GDP in the next three years, as the new government engineered significant rises in public expenditure, which took total government expenditure from 33.2% of GDP in 1980, to 47.8% in 1985 (Table 3). In fact, in 1985, another election year, the PSBR/GDP ratio shot up to 17.9%. External debt rose by 10 full percentage points of GDP in that year alone. The socialist government held on to power in the 1985 elections, but a few months later, in crisis conditions, negotiated a loan from the EC, and instituted a stabilization programme. This was based on a devaluation and a

draconian incomes policy, but had little impact on the PSBR. The PSBR/GDP ratio was reduced only to 14% and 13.2% in 1986 and 1987 respectively, and when the stabilization policy was abandoned in late 1987, it started climbing up again, to 16.1 in 1988 and 21.5% in the election year of 1989.

We thus see a spectacular upward ratchet of the PSBR in succesive elections. In between elections there were only weak attempts to reverse these rises. As a result, public debt rose from 27.4% of GDP in 1979 to 100% (possibly more) in 1989. A large part of the rise in public sector debt was due to government debt (Figure 1) which accelerated sharply as a percentage of GDP. External public sector debt more than quintupled as a percentage of GDP between 1979 and 1988, accounting for the lion's share of the rise in external indebtedness.

The major reason for the rise in public sector deficits and debts appears to have been the sharp rise in government expenditure (Table 4). The share of government expenditure in GDP rose by almost 50%, from 33.2% in 1980 to 49.4% in 1988. The rise has been concentrated to transfer and social insurance payments, government consumption, but more ominously on interest payments. The growth of these items has not been reversed by the stabilization program of 1985–87, which, as was suggested above, was mainly based on a devaluation and a draconian incomes policy.

The conservatives were returned to power in 1990, and have announced a gradualist approach to the reduction of public deficits. For example, the budget forecast for the PSBR/GDP ratio was 16% in 1990, with further gradual reductions until 1992, when the PSBR/GDP ratio is forecast to fall to 13.5% (*Kathimerini*, June 1, 1990). Is such a program sufficient for stabilization of public and external debt? In the remainder of this paper we turn to the medium run implications of fiscal deficits for external debt and inflation, and on the various stabilization policy options open to the authorities in Greece.

II. A MODEL OF OPTIMAL SAVINGS, DEFICITS AND DEBTS

In this section we utilize a neoclassical long run equilibrium model, which rests explicitly on the assumption of intertemporal optimization on the part of private households. The model belongs to a very wide class of models in this spirit, which assume that households have a finite horizon. The specific model we use is the Yaari–Blanchard model (Yaari 1965, Blanchard 1985), according to which each household is assumed to face a constant probability of death λ at each instant. In fact, we use a variant of the version due to Buiter (1988), which allows for both population and productivity growth.

II.1 *Optimal Savings by the Household*

Assume an economy consisting of a large number of households, born at different times in the past. All households are alike in all respects, apart from their date of birth. A fraction β of new households are added to the economy at each instant, and a fraction λ of old households die. The probability of death of a household is assumed constant and independent of the age of the household.

With a constant probability of death λ, and continuous time, the expected lifetime of a household is given by,

$$\int_0^{\infty} t\lambda e^{-\lambda t} dt = \frac{1}{\lambda}$$

The horizon of the household is thus equal to $1/\lambda$.

Under the assumption that individual utility is logarithmic, the household born at time s is modelled as maximizing the following expected utility function as of time t.

$$E_t\left[\int_t^{\infty} log[c_T(s,v)^{\phi} c_N(s,v)^{1-\phi}]e^{\delta(t-v)}dv\right] \quad ; \quad \phi < 1 \qquad (1')$$

where E is the mathematical expectations operator, c_T is household consumption of internationally traded goods, and c_N is household consumption of home (non-traded) goods. δ is the pure rate of time preference, and ϕ is a parameter.

Under the assumption that the only source of uncertainty is about the time of death, the problem of the household can be written as,

$$\max_{\{c_T(s,v),\ c_N(s,v)\}} \int_t^{\infty} log[c_T(s,v)^{\phi} c_N(s,v)^{1-\phi}]e^{(\delta+\lambda)(t-v)}dv \qquad (1)$$

subject to,

$$\dot{\alpha}(s,v) = [r(v)+\lambda]\alpha(s,v) + \omega(s,v) - c(s,v) \qquad (2)$$

where α denotes the real assets of household s. A dot above a variable denotes its time derivative. r is the real interest rate, and ω is the real labour income of the household assumed exogenous. All real variables, including the real interest rate, are expressed in terms of the price of home goods.

Households are allowed to take life insurance. At the time of their death their non-human wealth is tranferred to insurance companies, who in return pay households an income stream consisting of instantaneous payments equal to a proportion λ of their non-human wealth. We assume (following Yaari 1965) that the insurance industry is competitive. Also note that the effective discount rate of future instantaneous utilities is higher than the pure rate of time preference, as the household takes into account the probability of death.

The first order conditions for a maximum of (1) subject to (2) are the following:

$$\frac{c_T(s,v)}{c_N(s,v)} = \frac{\phi}{1-\phi} Q(v)^{-1} \tag{3a}$$

$$c_N(s,v) = [r(v)-\delta]c_N(s,v) \tag{3b}$$

$$c_T(s,v) = [r(v)-\delta-\frac{\dot{Q}(v)}{Q(v)}]c_T(s,v) \tag{3c}$$

where Q is the real exchange rate, defined as the relative price of traded goods.

The first order conditions have a standard interpretation. (3a) suggests that the household will seek to maintain a constant ratio between its consumption of traded and non–traded goods, and is a direct consequence of the Cobb–Douglas assumption. (3b) and (3c) suggest that consumption of each good will be increasing if the corresponding real interest rate exceeds the rate of time preference, it will be constant if the two are equal, and it will be negative if the rate of time preference exceeds the real interest rate.

From the constant shares property of the Cobb–Douglas utility function we can use (3b) and (3c) to derive the equation of motion of total household consumption c, which is given by,

$$\dot{c}(s,v) = [r(v)-\delta]c(s,v) \tag{4}$$

where $c(s,v) = c_N(s,v) + Q(v)c_T(s,v)$.

(2) and (4) are the equations of motion of non–human wealth and consumption (savings) respectively for the household born at time s.

II.2 *Aggregation*

Assume a birth rate equal to $\beta > 0$. Then, normalizing population at time 0 to unity, population at time t is given by,

$$N(t) = \beta e^{-\lambda t} \int_{-\infty}^{t} e^{\beta s} ds \qquad (5)$$

Under the assumption that all households receive the same labour income, it is straightforward to show (see Blanchard 1985 or Buiter 1988) that aggregate consumption, non-human wealth and human wealth evolve according to,

$$C(t) = (\delta+\lambda)[\, A(t) + H(t)\,] \qquad (6a)$$

$$\dot{A}(t) = r(t)A(t) + \Omega(t) - C(t) \qquad (6b)$$

$$\dot{H}(t) = [r(t)+\beta]H(t) - \Omega(t) \qquad (6c)$$

where capital letters denote aggregate variables. C is aggregate consumption, A is aggregate non-human wealth of households, H is aggregate human wealth, and Ω is aggregate labour income.

Again (6a)-(6c) have a standard interpretation. According to (6a) consumption is a constant fraction of the sum of human and non-human wealth. (6b) and (6c) are standard accumulation equations. The presence of β in (6c) reflects the fact that all surviving households, even the newborn, have the same human capital.

The production side of the economy will be assumed very simple. Labour is the only factor of production, and technology is linear in employment in both the traded and non-traded goods sectors. Both sectors are competitive. The equilibrium real exchange rate is thus given by relative marginal productitivies of labour. In what follows relative marginal productivities will be assumed equal and the real exchange rate is thus normalized to unity.

However, following Buiter (1988), we shall assume that there is a constant instantaneous proportional rate of growth of productivity θ. By choice of units the level of productivity in both sectors at time 0 is equal to unity. With this additional assumption, the equations of motion of aggregate variables as a fraction of labour

income Ω are given by,

$$c(t) = (\delta+\lambda)[\alpha(t)+h(t)] \tag{7a}$$

$$\dot{\alpha}(t) = [r(t) - (\beta-\lambda+\theta)]\alpha(t) + 1-c(t) \tag{7b}$$

$$\dot{h}(t) = [r(t) + \lambda - \theta]h(t) - 1 \tag{7c}$$

where $x(t) = X(t)/\Omega(t)$ for $x = c, \alpha, h$.

Eliminating human capital between (7a)–(7c), we end up with,

$$\dot{c}(t) = [r(t) - (\delta+\theta)]c(t) - \beta(\delta+\lambda)\alpha(t) \tag{8a}$$

$$\dot{\alpha}(t) = [r(t) - (\beta-\lambda+\theta)]\alpha(t) + 1-c(t) \tag{8b}$$

(8a) and (8b) are the equations of motion of the consumption–labour income ratio and the wealth–labour income ratio. Their properties are familiar from the Yaari–Blanchard model.

To proceed any further we need to specify the forms in which non–human wealth is held, and introduce the government.

II.3 *Public Sector Deficits and Debts in a Small Open Economy*

Assume a small open economy in which there are only two assets: foreign bonds f, and government bonds b. Given the absence of risk in the model, other than the probability of death, the two types of bonds are perfect substitutes for households (see Giovannini 1988). In such an economy, given the structure of production assumed in the previous section, Gross Domestic Product (GDP) is equal to total labour income Ω. Thus, the variables in (8a) and (8b) are the consumption/GDP ratio and private assets/GDP ratio respectively.

Assume a government that spends an amount g on goods and services, levies lump sum taxes τ, and borrows by issuing government debt b. g, τ and b are ratios to GDP, i.e Ω. With the introduction of the government, (8a) and (8b) are amended to,

$$c(t) = [r(t) - (\delta+\theta)]c(t) - \beta(\delta+\lambda)\alpha(t) \quad (9a)$$

$$\alpha(t) = [r(t) - (\beta-\lambda+\theta)]\alpha(t) + 1-\tau(t)-c(t) \quad (9b)$$

$$b(t) = [r(t) - (\beta-\lambda+\theta)]b(t) + g(t)-\tau(t) \quad (9c)$$

$$f(t) = [r(t) - (\beta-\lambda+\theta)]f(t) + 1-c(t)-g(t) \quad (9d)$$

$$\alpha(t) \equiv b(t) + f(t) \quad (9e)$$

From (9c), the change in the public debt to GDP ratio is driven by the primary deficit of the government $g-\tau$, while from (9d) the change in the external debt to GDP ratio is driven by the trade deficit $c+g-1$.

It is straightforward to see from (9a)-(9e) that the model can be first solved for the consumption and private asset ratios to GDP by using equations (9a) and (9b), and then it can be solved for the distribution of the private sector assets between foreign and government bonds.

The system of (9a) and (9b) is linear in consumption and external debt. It will be saddlepoint stable if $(r-\delta-\theta)(r-\beta+\lambda-\theta)$ is less than $\beta(\delta+\lambda)$. Sufficient conditions for saddlepoint stability are that the real interest rate is no higher than either the growth rate of GDP $(\beta-\lambda+\theta)$, or the sum of the pure rate of time preference and productivity growth $(\delta+\theta)$. However, neither of these conditions is necessary. The economy could be saddlepoint stable if the birth and death rates, and the pure rate of time preference, are sufficiently high relative to the difference of the real interest rate from both the growth rate of GDP, and the sum of the rates of time preference and productivity growth. If the condition for saddlepoint stability is not satisfied, and the real interest rate is too high, then the aggregate consumption/GDP ratio would be increasing for ever. In what

follows we exclude this pathological case, by assuming that the condition for saddlepoint stability is satisfied. In such a case there is a well defined steady state.

The determination of the steady state and the associated saddlepath dynamics are depicted in Figures 2 and 3. The $\dot{c} = 0$ and $\dot{\alpha} = 0$ lines represent the particular solutions of (9a) and (9b) when the private consumption and asset ratios to GDP respectively are constant. The vertical arrows show the direction of change in consumption and the horizontal arrows show the direction of change of assets in the relevant quadrants. The slope of the constant consumption line will be positive if the real interest rate exceeds the sum of the pure rate of time preference and the rate of growth of labour productivity (Figure 2), and negative if it falls below this sum (Figure 3). In the first case, steady state private non-human wealth will be positive, and in the second negative. The $\dot{\alpha} = 0$ line will be positively sloping if the real interest rate exceeds the growth rate of GDP, and negatively sloping in the opposite case. Both types of equilibria, with positive and negative private assets, will be assumed saddlepoint stable and consumption is the variable that jumps to put the economy on the saddlepath.

Let us first consider the case in which the real interest rate exceeds the sum of the pure rate of time preference and the growth rate of productivity. This case is depicted in in Figure 2. In steady state the private sector is a net lender, i.e private sector assets relative to GDP are positive. If the real interest rate also exceeds the growth rate of GDP, then in steady state private consumption is higher than disposable labour income $(1-\tau)$, as consumers also consume part of their asset income (Figure 2a). If the real interest rate falls short of the growth rate of GDP, then in steady state private consumption is lower than disposable labour income, as households must add to their assets at a rate higher than the real interest rate to maintain a constant ratio to the fast growing GDP (Figure 2b). In the case of equality between the real interest rate and the growth rate, steady state aggregate consumption equals disposable labour income, as the $\dot{a} = 0$ line would be horizontal. In all cases the saddlepath is positively sloping. This means that if private sector assets are lower than their steady state level, consumption

is also lower than its steady state level, ensuring that private sector assets are rising during the adjustment. If private sector assets are higher than their steady state level, then private consumption exceeds its steady state level, and there is decumulation of private sector assets towards the steady state.

If the real interest rate falls short of the sum of the pure rate of time preference and the rate of productivity growth ($r<\delta+\theta$), as in Figure 3, then the private sector is a net borrower in equilibrium (its assets are negative). In steady state, consumption is again positive but private sector assets (non-human wealth) are negative. The saddlepath is again positively sloping. The cases in Figures 3a and 3b correspond to the cases in Figures 2a and 2b respectively. In what follows we shall ignore this case, as the data suggest that the private sector in Greece is a net lender, which, in terms of our model, suggests that the real interest rate exceeds the sum of the pure rate of time preference and the rate of productivity growth.[5]

For completion, let us briefly consider the case where the real interest rate equals the sum of the rates of time preference and productivity growth, $r = \delta+\theta$. In that case, the $\dot{c} = 0$ line is vertical through the origin, and the value of steady state private assets is equal to zero, as the domestic household sector neither saves nor dissaves in the steady state. Aggregate consumption in steady state simply equals disposable labour income.

The expressions for steady state private sector assets and consumption are given below.

$$\bar{\alpha} = \frac{r-\delta-\theta}{\beta(\delta+\lambda)-(r-\delta-\theta)(r-\beta+\lambda-\theta)}(1-\bar{\tau}) \tag{10}$$

$$\bar{c} = \frac{\beta(\delta+\lambda)}{\beta(\delta+\lambda)-(r-\delta-\theta)(r-\beta+\lambda-\theta)}(1-\bar{\tau}) > 0 \tag{11}$$

[5]A different explanation for this stylized fact could be that the private sector is subject to credit constraints. Although this may be a plausible explanation for short periods, we do not find it very convincing for the longer term which is what this paper is concerned with.

A bar above a variable denotes its steady state value. Note that the denominator in both expression will be positive if the condition for saddlepath stability is satisfied. With saddlepath stability steady state consumption will always be positive. Non-human wealth will only be positive if $r > \delta+\theta$, as suggested above.

We can now turn to one of major concerns in this paper, namely the implications of different ways of stabilizing a rising ratio of public debt to GDP.

III. STABILIZING A RISING PUBLIC DEBT/GDP RATIO

We saw in section I that the 1980s have witnessed a significant and almost continuous rise in Greece's ratio of the public debt to GDP. What are the implications for tax revenue, government expenditure and external debt if the government were to try to stabilize the public debt to GDP ratio? This section examines the theoretical aspects of the available options.

A rising public debt to GDP ratio occurs when the government is running public sector deficits which, as a percentage of GDP, exceed the product of the growth rate of GDP and the debt/GDP ratio. Consider equation (9c).

$$\dot{b}(t) = [r(t) - (\beta-\lambda+\theta)]\, b(t) + g(t) - \tau(t) \; > \; 0 \qquad (9c)$$

$\dot{b}$ will be positive if the sum of interest payments on public debt and non-interest government expenditure exceeds tax revenues and the growth induced reduction in the debt/GDP. When $r > \beta+\lambda-\theta$ (i.e when the real interest rate exceeds the growth rate) the process of public debt accumulation will be dynamically unstable. The ratio of public debt to GDP b will be rising for ever, unless there is some discretionary rise in tax revenues, or some discretionary fall in government expenditure to put a stop to this process. If $r < \beta+\lambda-\theta$, the public debt to GDP ratio will converge to a steady state

value, but if it is currently rising, it will converge to a higher value than the current one.

The thought experiment we shall consider in this section and the next is the following: Assume that the government faces a rising public debt to GDP ratio. What would happen if the government followed alternative discretionary actions to stabilize it at its current levels.[6]

When the real interest rate exceeds the growth rate, the government can only stabilize the ratio of its debt to GDP by either producing a primary surplus, or using inflationary finance. If the growth rate exceeds the real interest rate it must reduce its primary deficit, but need not produce a surplus. In any case, ignoring inflationary finance for the moment, what is needed is either an increase in average taxation or a reduction in (non-interest) government expenditure. We shall examine these two options in turn.

III.1 *Public Debt Stabilization through Higher Taxation*

The steady state relationship between taxes, debt and government expenditure is given by the particular solution of equation (9c) for a constant $\bar{b}$. Solving it for τ we get,

$$\bar{\tau} = (r-\beta+\lambda-\theta)\bar{b} + \bar{g} \qquad (12)$$

Consider the following experiment: Starting from steady state, the government increases the share of government expenditure and announces that it will stabilize the public debt to GDP ratio at a higher level through higher future taxes. The case where the real interest rate exceeds the growth rate is depicted in Figure 4.

The rise in steady state taxation will cause a downward shift in the $\dot{\alpha} = 0$ curve,

[6]Alternative ways of stabilizing the public debt to GDP ratio, that rest on reaction functions of the primary deficit are sketched in Appendix 1. This also contains a fuller stability analysis of the model.

which will result in lower steady state private consumption and private real assets (from point A to point C in Figure 4). Thus, external debt will increase on two counts. It will increase because of the substitution of government debt for foreign assets in the portfolios of households, and it will also increase because of the decumulation of assets that will occur in response to the higher steady state taxation. The impact effect of such a program will be a sharp fall in private consumption (point B). This will be followed by further gradual falls in the average propensity to consume and decumulation of external assets (capital flight) along the saddlepath, as the private sector tends towards its new steady state equilibrium with a lower non-human wealth to income ratio.

The case where the growth rate exceeds the real interest rate is similar in all respects, with the exception that public debt stabilization does not require a primary surplus but can be achieved with a primary deficit.

III.2 *Public Debt Stabilization through Lower Government Expenditure*

If the government were to opt for a stabilization of the public debt through a fall in g from its current levels, the effects will be different.

Consider the following experiment. Starting from steady state, the government implements a (temporary) rise in the share of government expenditure, and announces that it will stabilize the public debt to GDP ratio at a higher level through a future fall in the share of government expenditure.

With such a programme, neither steady state private consumption nor private sector assets will change as a proportion of GDP. During the adjustment, public debt accumulation will be matched one for one by external asset decumulation, and the steady state increase in external debt will thus be lower than in the case where future taxes go up. In the case of stabilization through reductions in government expenditure the rise in the external debt to GDP ratio is the same as the rise in the public debt to GDP ratio. With stabilization through higher taxation the rise in the external debt to

GDP ratio is higher than the rise in the public debt to GDP ratio, because private consumers also ran down their assets as a proportion of GDP by accumulating foreign debt.

When the real interest rate exceeds the growth rate, the eventual reduction of the share of non–interest government expenditure to GDP will have to be higher than the original increase. In the opposite case it will be lower than the original increase.

III.3 *Public Debt and External Debt Stabilization*

It is worth emphasizing something which is implicit in our discussion above, namely that stabilization of the public debt to GDP ratio is sufficient for the stabilization of the external debt to GDP ratio as well. No further action is needed on the part of the authorities. This is a direct consequence of the fact that the private sector, through its savings behaviour, stabilizes the ratio of its own assets to GDP, and the identity (9e) which states that private sector assets are the sum of government bonds and external assets.

In conclusion, stabilization of the public debt/GDP ratio will also stabilize the external debt/GDP ratio. In other words, the "external constraint" in this model is just the flip side of the government solvency constraint. However, the manner in which the public debt/GDP ratio is stabilized will affect both steady state private consumption and the level of the steady state external debt/GDP ratio. Stabilization through a reduction in government expenditure will cause no change in the steady state private consumption to GDP ratio, and will result in a rise in the steady state external debt to GDP ratio equal to the rise in the ratio of public debt. Stabilization through a rise in taxation will reduce the share of private consumption in GDP, and will result in a rise in the external debt/GDP ratio, that is higher than the rise in the ratio of public debt.

In the next section, we move on to examine the potential for public debt stabilization through higher inflation.

IV. SEIGNIORAGE, PUBLIC DEBT AND EXTERNAL DEBT

An additional way in which a rising public debt to GDP ratio can be stabilized in through an increase in seigniorage, i.e government revenue from money creation. With a stable money demand function and a constant steady state growth rate of GDP, an anticipated rise in the rate of growth of the money supply will result in higher expected and actual inflation.

IV.i *Higher Monetary Growth and Seigniorage*

An anticipated increase in monetary growth may or may not increase seigniorage, as this will depend on the initial rate of monetary growth and the interest rate semi-elasticity of money demand. An increase in anticipated monetary growth will raise anticipated inflation and this will be reflected in higher nominal interest rates, which will reduce the proportion of money balances to GDP. To see this point, let us assume an interest-elastic demand for money function of the following form.

$$\frac{M(t)}{P(t)} = k\Omega(t)e^{-\eta[r(t)+\pi(t)]} \qquad (14')$$

M is the nominal money supply, P the price level, π is expected inflation and k is a constant. It is assumed that an increase in the nominal interest rate reduces money demand.[7]

Differentiating (14′) with respect to time, assuming a constant real interest rate and a constant expected inflation rate, after some re-arrangement we get,

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[7]Note that the demand for money function is postulated rather than derived from the optimization problem of households. This is mainly for simplicity, but it also reflects the lack of consensus about the appropriate microfoundations of money demand.

$$\pi = \mu - (\beta - \lambda + \theta) \tag{15}$$

where μ is the rate of growth of the money supply, $(\beta - \lambda + \theta)$ is the growth rate of GDP, and π is inflation. Thus, an anticipated permanent rise in μ will cause a rise in π in the same proportion. What will be the effect on steady state seigniorage? To examine this it is worth writing money demand as a fraction of GDP. Dividing both sides of (14') by Ω we get,

$$m = \frac{M}{P\Omega} = ke^{-\eta(r+\pi)} \tag{14}$$

where m is the ratio of money balances to GDP, and where the time index has been suppressed.

Steady state seigniorage as a percentage of GDP is equal to,

$$\sigma = \mu m \tag{16}$$

Using the money demand function (15) and the relation between money growth and expected inflation (15), we can see that,

$$\frac{\partial \sigma}{\partial \mu} = (1 - \eta\mu)m = [1 - \eta(\pi + \beta - \lambda + \theta)]m \tag{17}$$

Whether seigniorage as a percentage of GDP rises or falls with a rise in the rate of growth of the money supply and inflation will depend on whether the product of the initial rate of monetary (or nominal income) growth and the interest rate semi-elasticity of money demand is less than or higher than unity. For low enough rates of monetary (nominal income) growth we are on the rising part of this "Laffer curve" (see Figure 5). Maximum seigniorage is being extracted when the rate of monetary growth is equal to

the inverse of the interest rate semi-elasticity of money demand. When the rate of monetary growth exceeds this threshold, seigniorage as a proportion of GDP falls with a rise in monetary growth.

IV.2 *The Model with the Addition of the Money Market*

The model described in equations (9a) to (9e), with the addition of real money balances to real private sector wealth, the inflation tax and seigniorage revenue, is amended as follows (money demand is given by (14)):

$$\dot{c}(t) = [r(t) - (\delta+\theta)]c(t) - \beta(\delta+\lambda)\alpha(t) \tag{9a}$$

$$\dot{\alpha}(t) = [r(t) - (\beta-\lambda+\theta)]\alpha(t) + 1-\tau(t)-[r(t)+\pi(t)]m(t)-c(t) \tag{9'b}$$

$$\dot{b}(t) = [r(t) - (\beta-\lambda+\theta)]b(t) + g(t)-\tau(t)-[\pi(t)+\beta-\lambda+\theta]m(t) \tag{9'c}$$

$$\dot{f}(t) = [r(t) - (\beta-\lambda+\theta)]f(t) + 1-c(t)-g(t) \tag{9d}$$

$$\alpha(t) = m(t) + b(t) + f(t) \tag{9'e}$$

The inflation tax as a percentage of GDP is equal to the nominal interest rate times the money/GDP ratio (9'b), while seigniorage as a percentage of GDP is equal to the growth rate of nominal income times the money/GDP ratio. The difference between the two is equal to the product of the money/GDP ratio and the difference between the real interest rate and the growth rate of GDP.

The steady state solutions for consumption and private sector wealth are now as follows:

$$\bar{\alpha} = \frac{r-\delta-\theta}{\beta(\delta+\lambda)-(r-\delta-\theta)(r-\beta+\lambda-\theta)}\,[1 - \bar{\tau} - (r+\pi)\bar{m}\,] \tag{10'}$$

$$\bar{c} = \frac{\beta(\delta+\lambda)}{\beta(\delta+\lambda)-(r-\delta-\theta)(r-\beta+\lambda-\theta)}\,[1 - \bar{\tau} - (r+\pi)\bar{m}\,] > 0 \tag{11'}$$

If the economy is to the left of the seigniorage "Laffer curve", an increase in steady state inflation will reduce private sector assets and private consumption as a proportion of GDP, as it will raise the share of the inflation tax.

IV.3 *Public Debt Stabilization through a Rise in Seigniorage*

What are the implications of using a rise in steady state monetary growth for public debt stabilization, private consumption and external debt?

Public debt stabilization requires from (9'c) that,

$$(\pi+\gamma)m = \mu k e^{-\eta(r+\mu-\gamma)} = (r-\gamma)b + g - \tau \qquad (18)$$

where γ is the steady state growth rate defined as $\gamma \equiv \beta-\lambda+\theta$.

Assume that the government opts for public debt stabilization through a rise in steady state monetary growth. We shall again consider thought experiments similar to the ones examined before.

Starting from steady state, consider a rise in government expenditure and public debt as shares of GDP, financed through higher seigniorage. We shall again start with the case when the real interest rate exceeds the growth rate. In fact, in this case seigniorage must rise by enough, to cover both the higher primary fiscal deficit, and the part of interest payments on the increased public debt which is not paid for by economic growth. This case is depicted in Figure 6.

The rise in steady state seigniorage will cause a downward shift in the $\alpha = 0$ curve, as it will be associated with an increase in the inflation tax. This, as in the case of the increase in tax rates, will reduce steady state private consumption and private real assets. External debt will increase if the reduction in the private asset/GDP ratio exceeds the reduction in the money/GDP ratio brought about by higher steady state

inflation. In any case, external debt will increase by less than in the case of higher taxation. The reason is that part of the reduction in private sector assets is achieved through the reduction in real money balances implied by higher nominal interest rates. Thus, there is less of a need to reduce foreign assets.

In conclusion, public debt stabilization through inflation will result in the same reduction in private consumption as public debt stabilization through higher taxation, and the same reduction in private sector assets. However, there will be less of an increase in the external debt to GDP ratio that in the case of tax finance, because inflationary finance also causes a reduction in real money balances as a percentage of GDP.

IV.4 *The Tradeoff between Inflation and External Debt*

The above analysis suggests that to stabilize the public debt to GDP ratio at a given value, there is a tradeoff between steady state external debt and inflation. The higher the weight of monetary finance, the lower the external debt to GDP ratio. The tradeoff is depicted by the convex curve in Figure 7. The equilibrium inflation rate and external debt to GDP ratio will be determined at the point of tangency of this curve and the government's indifference curves, assuming that the government dislikes both inflation and external debt.

Figure 7 can be used to analyze what would happen to external debt and inflation following a permanent rise in government expenditure accompanied by a steady state rise in the ratio of public debt to GDP. Such a policy would shift the tradeoff to the right, and the government has two options in trying to stabilize the higher public debt to GDP ratio. The first is to raise taxes, which would result in high external indebtedness, and the second is to raise seigniorage, which would result in lower external indebtedness, but higher steady state inflation. If the government dislikes both inflation and external debt, it will opt for a mix of tax and inflationary finance (Mankiw 1987,

Grilli 1989). The economy will move from E to E′ Thus, in the new equilibrium, both the external debt to GDP ratio and the inflation rate will rise.

IV.5 *External versus Public Debt Targets and Inflation*

We have concentrated up to now on the case where the government stabilizes the public debt to GDP ratio through different means, allowing the external debt to GDP ratio to settle at whatever level is required. Alternatively, the government could be choosing to stabilize the external debt to GDP ratio at its current level, or, more generally, it could have an external debt to GDP target. To see the effects on policy options and the public debt from some targets, we can use (9'e), (10') and (18) to arrive at the following relation between the external debt target, inflation, taxation and government expenditure.

$$(r+\pi)\psi m = (r-\gamma)(-\bar{f}) + g - \psi\tau \qquad (19)$$

where $\psi = \frac{\beta(\delta+\lambda)}{\beta(\delta+\lambda)-(r-\delta)(r-\gamma)}$.

For given government expenditure, equation (19) provides long run combinations between income tax and inflation which are long–run compatible with external debt targets. With external debt targets, the rise in inflation and taxes reduces private sector wealth in a similar way as with public debt stabilization. However, in this case, because the government has an external debt target, the private sector will arrive at its optimal wealth to GDP ratio by off–loading government bonds rather than external assets. Thus, if the government if trying to stabilize a rising external debt to GDP ratio, it will reduce the public debt/GDP ratio below its current level. Accordingly, the required seigniorage will be lower for given taxes and government expenditure.

Having analyzed the alternative options, we turn to the details of the Greek case.

V. PUBLIC AND EXTERNAL DEBT STABILIZATION IN GREECE

We have seen in section I that the rise in Greece's external indebtedness went hand in hand with the rise in inflation and the GDP shares of government expenditure and public sector debt. In this section we are concerned with the implications of alternative options for public and external debt stabilization.

To get beyond the theoretical arguments contained in the previous section, we calibrate the model by using appropriate numerical parameter values corresponding to the Greek economy. The parameters we chose are summarized in Table 5 and its footnote.

The parameter of 2.5% for the pure rate of time preference has been taken from Alogoskoufis and Nissim (1981). λ has been assumed equal to 1%, which is approximately equal to the the inverse of life expectancy in Greece (73 years). β, the rate of birth of new households has been calculated by subtracting λ from the rate of growth of population of age 15–64, which was equal to 0.7% per annum on average for the 1960–88 period. η has been assumed equal to 5.6. This is our best estimate of the interest rate semi–elasticity of money demand using annual data (see Appendix 2). k has been assumed equal to 60%. This has been calculated from the estimates of the money demand function (Appendix 2), noting that recent velocity at 20% inflation rates was equal to about 5. With regard to the other parameters of the model we have examined two growth scenaria, a "gloomy" one ($\gamma = \beta - \lambda + \theta = 2\%$ per annum), which happens to be in accordance with OECD projections for 1990 and 1991, and a "rosy" one ($\gamma = 4\%$ per annum). We also examine two real interest rate scenaria (3% and 5%).

Note that with an estimate of the interest rate semi–elasticity of money demand equal to 5.6, the seigniorage maximizing nominal income (monetary) growth rate is equal to 18%, slightly lower than Greece's average growth of nominal income in the 1980s, which was 20%. Thus, the estimates of money demand reported in Appendix 2, as

well as other estimates of money demand in Greece, suggest that the government cannot hope to get more steady state seigniorage by higher monetary growth. The option of public (and external) debt stabilization from their currently rising values through higher inflation simply does not exist.

V.1 *Tradeoffs between Steady State Inflation Rates and Public Deficits*

Table 5 reports the tradeoffs between inflation and the primary budget surplus that, according to the model, would ensure stabilization of the public debt to GDP ratio at its current ratio to GDP of approximately 100%. The estimates highlight that with budget deficits of the order that Greece has been experiencing in recent years, the government is clearly insolvent. In fact, if the government is insolvent, so is the country, as an unsustainable public debt accumulation process implies an unsustainable external debt accumulation process.

In the 2% "gloomy" growth scenario, with world real interest rates of about 5% per annum, solvency requires that the government achieves a primary budget deficit of only 0.3% of GDP if inflation rates stay at their current level of about 20% per annum. If Greece were to contemplate joining the EMS, and eventually the EMU process, it would need to live with inflation rates of about 5% per annum or less. In that case, to be solvent, the public sector ought to be running a primary surplus of 0.6% of GDP. In the case of lower world interest rates, solvency could be achieved with higher budget deficits. For example, to stabilize the public debt to GDP ratio with world interest rates of 3% per annum, the government of Greece would need to reduce the primary budget deficit to 2.6% of GDP if inflation were to remain in the region of 20%. With the lower inflation rate that would be implied by membership of the exchange rate mechanism of the EMS, the primary budget deficit would have to fall to 1.7% of GDP.

If the growth rate were to rise to nearer the levels of the 1970s (say the "rosy" scenario of 4% per annum), the deficit reduction requirements are that much looser.

With 20% inflation, the primary deficits that would stop the debt/GDP ratios from rising are 2.6% with a real interest rate of 5% and 5.0% with a 3% real interest rate. If inflation were to fall to 5%, these targets fall to 2.1% and 4.5% respectively.

Note, however, that as was suggested above, current forecasts of the OECD for GDP growth in Greece are nearer to the "gloomy" growth scenario. The June 1990 *Economic Outlook* forecasts growth rates of 1.4% in 1990 and 2.1% in 1991 (p. 113). Its forecast for the primary deficit of the general government (i.e excluding interest payments) is 6.5% of GDP in 1990 and 5.1% in 1991. This is a far cry from the 0.3% primary deficit that we calculate would be required to stabilize public and external debt ratios. The average gap that must be closed in the two years of 1990 and 1991 is 5.5 percentage points of GDP per annum.[8]

V.2 *Implications for Steady State Taxes and External Debt*

We next turn to the implications of the choice of different steady state inflation rates (seigniorage) for taxes and external debt. Table 6 contains some calculations for the "gloomy" (but realistic) scenario of 5% real interest rates and 2% growth rates. The differences in the share of taxes are very small for inflation rates between 5% and 25%. The ratio of taxes to GDP is of the order of 40%, to roughly maintain a zero primary deficit. However, different inflation rates have profound implications for external debt. If steady state inflation were to be reduced from 15% to 5%, the external debt to GDP

[8]The June 1990 issue of OECD's *Economic Outlook* contains calculations of indicators of the sustainability of fiscal policy in the OECD countries. These are similar to our sustainability indicator in that they measure the reduction of the primary deficit in percentage points of GDP, so that the public debt to GDP ratio is immediately stabilized. The OECD measure for Greece (by far the highest in the relevant Table in page 18) is 7.7% of GDP on average for 1990 and 1991. Our own measure of this primary deficit gap is 5.5% (the average of 6.5 minus 0.3 and 5.1 minus 0.3). There must be slight differences in definitions and interest rate assumptions. However, what seems to fully account for the discrepancy is the treatment of seigniorage revenue. The OECD measure does not seem to take it into account. The advantage of our measure is that it does. In fact, we assume 20% inflation rates, which is the OECD forecast for Greek inflation. On the assumption of zero inflation, our measure of the primary deficit gap is 7.9%, which is very close to the OECD number.

ratio associated with a stable 100% public debt to GDP ratio rises from 40% of GDP to 62% of GDP. The reason is that the reduction in steady state inflation (and nominal interest rates) increases the demand for money, and private households dispose of external assets to maintain a constant ratio of their assets to income. The large reduction in foreign assets is a reflection on the high estimate of the interest rate semi-elasticity of money demand. With a rise of the average inflation rate to 25%, the external debt to GDP ratio would fall to 27%.

V.3 *The Dangers of a Delayed Stabilization, or Why Gradualism is not an Option*

It should be noted that the above analysis is based on the assumption that fiscal policy is immediately adjusted to ensure solvency. If action is delayed, public debt will continue to rise, and stabilization will require increasingly tougher measures. Equation (18) can be used to determine the upper bound on debt, beyond which a conventional stabilization is not feasible. After this is reached, the government will have to resort to debt repudiation or a surpise hyperinflation to wipe out part of its debt.

Feasibility is ensured only when the primary surpluses implied by (18) do not exceed the maximum possible level, defined as,

$$s_{max} = \tau_{max} - g_{min} \tag{20}$$

where s_{max} refers to the maximum primary surplus, τ_{max} to maximum average taxes and g_{min} to the minimum share of government expenditure, given institutional and social constraints.

Consider the following example: Seigniorage is at its maximum possible level, i.e roughly 2.6% of GDP, with inflation rates of 20%. Assume that fiscal toughness cannot go beyond achieving a primary surplus of 1% of GDP ($s_{max}=0.01$). Then, a crisis will occur when public debt reaches 120% of GDP, under the low growth scenario (γ=2%),

with real interest rates at 5% per annum. If no actions were taken, and public sector deficits continued at the 1989 levels of about 20% of GDP, debt would have reached this crisis threshold in early 1991. With the deficit reduction package announced by the government in the 1990 budget, this may be delayed for a further 1–2 years. When and if the crisis point is reached, the only actions available will be a a reduction in the debt stock, which could be achieved either by government fiat (say a repudiation of part of domestic debt) or a surprise hyperinflation.

One could, of course, reach different conclusions by making alternative assumptions about s_{max}. Needless to say, the above example, as indeed all of the calculations should be taken as indicative. A number of assumptions and forecasts are built into them, and they rely on the calibration of a rather simple model. However, it is also worth saying that these calculations are quite robust, and similar to those reached by other experts (e.g the OECD). Even if the exact numbers are wrong, we feel they are of the right magnitude, and that they show the order of the task of stabilizing the rising public and national indebtedness of Greece.

VI. CONCLUSIONS

The conclusions of this paper can be summarized as follows: The rise in Greece's external indebtedness in the 1980s can be directly attributed to the rapid growth of government expenditure and the persistently high budget deficits. The rise in world real interest rates and the slowdown in economic growth have, of course, attenuated the rise in domestic and external debt.

We have shown that if private households are forward looking, public debt stabilization is a sufficient condition for external debt stabilization. However, the way in which public debt is stabilized, has implications for the equilibrium level of external debt. Public debt stabilization through a reduction in government expenditure will result in the lowest steady state external debt to GDP ratio than any other option. The

other two possible options are an increase in seigniorage revenue and an increase in taxes.

We showed that the average inflation rate in Greece is at a level that maximizes steady state seigniorage. A further rise in the proportion of seigniorage revenue is not possible. A reduction in government expenditure and an increase in taxes are thus the only feasible alternatives.[9]

We have provided some calculations which show that the primary budget deficit must be reduced immediately to 0.3% of GDP for public and external debt to be stabilized. The OECD projection in the June 1990 *Economic Outlook* is that the general government primary deficit is going to be 6.5% of GDP in 1990 and 5.1% in 1991. Thus, according to our calculations in Table 5, the averate gap to be closed in 1990–91 is 5.5 percentage points of GDP per annum. Current plans will only lead to public and external debt stabilization if growth were to pick up to about 4% per annum, and world real interest rates were as low as 3% per annum. This is highly unlikely. Thus, the fiscal authorities in Greece have some way to go before public and external debt ratios are stabilized, and the danger of a crisis averted.

Our final word regards the possibility of drachma's entry in the exchange rate mechanism of the EMS, and Greece's eventual participation in EMU. This will lead to inflation rates of 5% or less, with associated losses in seigniorage revenue. Roughly, participation in the EMS will require an additional reduction of the primary deficit of about one percentage point of GDP in the low growth scenario, and half a percentage

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[9]In a recent survey of structural problems of the Greek economy, Katseli (1990) briefly considers macroeconomic stabilization. Apart from espousing gradualism, she reaches a strong conclusion about taxes. She argues that, "the brunt of the adjustment however has to be on the revenue side since total revenues cover only 60% of government expenditures in 1988, down from 87% in 1970 and 79% in 1980." (p. 303). This conclusion presupposes that the huge increases in government consumption and transfer payments that took place in the 1980s, and which were financed by borrowing, are socially desirable. It implies that the deferred taxes must now be levied with interest. We feel that such a conclusion in not warranted, and given the effects of higher taxes on external debt that are highlighed in our paper, as well as other disincentive effects, we would be extremely disinclined to endorse the view that the brunt of the adjustment has to be borne by taxation. The Greek tax system must be reformed for equity and efficiency reasons, but it is not at all clear that the average tax burden must rise.

point in the high growth scenario. The reduction in inflation will also lead to higher external debt than otherwise. However, given the order of the overall task of deficit reductions required for stabilization anyway, and the benefits the EMS seems to have brought to other countries anyway (see Giavazzi and Giovannini 1989), these seem trivial. Provided adequate further fiscal stabilization measures are undertaken, there is no reason why Greece could not immediately enter the exchange rate mechanism of the EMS.

APPENDIX 1

STABILITY ANALYSIS OF THE MODEL

We consider here the system of equations (9a) to (9e). Given the identity (9e), stability of the system can be characterized by only studying the dynamics of consumption, total private wealth and foreign assets. Domestic public debt is thus a residual and is stabilized whenever the other two stocks reach asymptotically stable ratios to GDP. (Note that the analysis in the text treats foreign assets as a residual).

Writing the model in state space form, one can easily see that the characteristic polynomial is equal to,

$$\phi(z) = (z-r+\gamma)\{ z^2 - (2r-\gamma-\delta-\theta)z + (r-\gamma)(r-\delta-\theta) - \xi \} \qquad (A1)$$

where $\xi = \beta(\delta+\lambda)$, and $\gamma = \beta-\lambda+\theta$. γ is the growth rate of GDP.

With some manipulation we get,

$$(r-\gamma)(r-\delta-\theta) -\xi = (r-\theta+\lambda)(r-\theta-\beta-\delta) \qquad (A2)$$

so that the characteristic polynomial is written as,

$$\phi(z) = (z-r+\gamma)\{z^2 - (2r-\gamma-\delta-\theta)z + (r-\theta+\lambda)(r-\theta-\beta-\delta)\} \qquad (A1')$$

Saddlepath stability requires two stable (negative) and one unstable (positive) roots. We distinguish two cases:

Case 1: $r < \gamma$

In this case, saddlepath stability is guaranteed if the quadratic equation has one stable and one unstable roots. The other is $z_3 = r-\gamma < 0$.

The condition for saddlepath stability then is that, $\theta-\lambda < r < \theta+\beta+\delta$. Since $\gamma = \beta-\lambda+\theta < \beta+\delta+\theta$, saddlepath stability obtains in the region,

$$\theta-\lambda < r < \beta-\lambda+\theta \qquad (A3)$$

In this case, stock to GDP ratios reach steady state finite values and consumption is a jumping variable.

Under the additional assumption that households are net lenders in equilibrium, consumption is positive for $r > \delta+\theta$. Since $\delta+\theta > \theta-\lambda$, the last condition is modified to,

$$\theta+\delta < r < \theta + (\beta-\lambda) \qquad (A4)$$

This is possible only if $\delta < \beta-\lambda$, i.e when the rate of pure time preference is lower than the population growth rate.

The upper–bound condition on the interest rate has the meaning that although assets accumulate because of interest payments, they become a decreasing proportion of GDP. Positive private sector savings (and public sector deficits) are thus sustainable.

Case 2: $r > \gamma$

In this case, saddlepath stability would only obtain if the quadratic equation in (A1′) had two negative roots. A necessary condition for that is,

$$2r < \gamma+\delta+\theta = \beta-\lambda+\delta+2\theta \qquad \text{(A5)}$$

Given that $r > \gamma$, this is only possible if $\delta > \beta-\lambda$, i.e when the rate of pure time preference is higher than the rate of population growth.

For the product of the roots we must have that,

$$(r-\theta+\lambda)(r-\theta-\beta-\delta) > 0 \qquad \text{(A6)}$$

which is satisfied for either $r < \theta-\lambda$, or $r > \theta+\beta+\delta$. In combination with $r > \gamma$ the first requires $\beta < \theta$ which is ruled out. The second contradicts (A5), since for (A5) to be satisfied it would require that $\beta+\lambda+\delta < 0$. Thus, $r > \gamma$ leads to instability. Note, however, that, as shown in the text, the sub-system of private sector assets and consumption is stable even in this case. What becomes unstable is the stock of foreign assets (and domestic bonds). The situation may be controlled by feedback fiscal policy rules to which we now turn.

Feedback Fiscal Policy Rules

In the case when $r > \gamma$ feedback fiscal policy rules can remove one extra unstable root in (A1′). Restricting attention to simple rules, we consider two alternatives:

Feedback on the current account deficit (flow rule)

$$(\tau-g) = s_0 + s_1 f \qquad \text{(R1)}$$

Feedback on the stock of external debt (stock rule).

$$(\tau - g) = s_0 + s_1 f \qquad \text{(R2)}$$

The flow rule suggests that the primary budget deficit falls as the current account deficit increases, while the second suggests that the primary budget deficit falls as external debt rises.

It is straightforward to show that flow rules of the type (R1) are not capable of stabilizing the process of external (and public) debt accumulation when the real interest rate exceeds the growth rate. The reason is that when fiscal policy responds only to changes in assets, the explosive process that accumulates assets cannot be stopped, as even with zero net deficits assets keep accumulating. To stabilize the process of external and public debt accumulation in this case one should adopt stock targeting rules, of the type (R2).

APPENDIX 2

ESTIMATES OF MONEY DEMAND FUNCTIONS

The most important parameter for assessing the extent to which an increase in the rate of monetary growth increases seigniorage revenue, is the interest rate semi-elasticity of money demand. Since this parameter is so crucial for the question of seigniorage, we report here on the results of an investigation of money demand in Greece.

The estimates are based on a log-linear version of equation (14′) in the text. Taking logarithms we get,

$$\ln M_t = \ln P_t + \ln \Omega_t - \eta i_t + \ln k_t \qquad \text{(M1)}$$

where i is the nominal interest rate.

A preliminary analysis suggests that one would not be able to reject the hypothesis that measures of money, prices, output and the opportunity cost of money are non–stationary.

To test for stationarity we ran the following regressions on each of the variables.

$$\Delta x_t = \alpha + \beta x_{t-1} + \Sigma_{j=1}^{n} \gamma_j \Delta x_{t-j} \qquad \text{(M2)}$$

where x is one of lnM, lnP, $ln\Omega$, i. The Dickey and Fuller (1979) statistic is based on the "t–ratio" of the coefficient β, when all the γ_j's are equal to zero, and the Augmented Dickey–Fuller statistic is based on the "t–ratio" of β, when at least some to the γ_j's are allowed to be non–zero. When the "t–statistic" of β is lower than the critical values tabulated in Fuller (1976), one cannot reject the hypothesis that the relevant series is non–stationary (has at least one unit root). The results for annual and quarterly data for Greece are tabulated in Table M1.

The Dickey–Fuller and Augmented Dickey–Fuller statistics suggest that one cannot reject the hypothesis that money, prices and the nominal interest have a unit root. Surprisingly, the unit root hypothesis seems to be rejected narrowly for GDP (annual data) and industrial production (quarterly data). However, when one allows for the change in the average growth rate of GDP and industrial production in the 1980s (by including a dummy variable that takes the value of one after 1980 and zero before), the unit root hypothesis cannot be rejected for GDP and industrial production either.

Given these results, the next question that arises is whether money, prices, income and nominal interest rates are cointegrated (Engle and Granger 1987). Cointegration tests are presented in Table M2. The results for both annual and quarterly data suggest that these variables are not cointegrated. In terms of the money demand function (M1) lack of cointegration can be interpreted as a non–stationary money demand shock k.

Assuming that lnk_t is a random walk with drift ϵ, the money demand function (M1) can be written as,

$$\Delta lnM_t = \epsilon + \Delta lnP_t + \Delta ln\Omega_t - \eta\Delta\imath_t + v_t \qquad \text{(M3)}$$

where v_t is the white–noise process driving the random walk in lnk_t.

Estimates of (M3) are presented in Table M3 for both annual and quarterly data. For each data set, the first column presents OLS estimates, and the second instrumental variables estimates, with the instruments being one lag of each regressor and the regressant.

The results suggest huge differences in the estimate of η between OLS and IV estimation. Since in the presence of simultaneity between money and interest rates the OLS estimates are inconsistent, we opt for the consistent IV estimates. The IV estimate of η for annual data is equal to 5.59 (ASE = 1.84), while for quarterly data it is equal to 9.89 (ASE = 3.95). Both estimates are statistically significant at conventional significance levels. Note that in OLS estimation there is a huge downward bias.

These estimates are not grossly at variance with the estimates of the interest rate semi–elasticity of money demand in previous studies. For example, Alogoskoufis (1985), using FIML in the context of a 3 equation macro–model for Greece, finds a long run semi–elasticity of money demand equal to 8.24 (ASE = 2.87).

In the calibration of the model in the text we opt for the lower estimate of 5.6 from the regression with annual data. This is based on a longer time span (1952–88) and incorporates some of the interesting macroeconomic episodes of the 1950s, and is probably based on better quality data (e.g GDP rather than industrial production as the income variable). In any case, the higher estimate in the quarterly regressions is not statistically different from 5.6, as it has a higher standard error as well.

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Table 1
Comparative Macroeconomic Developments
Greece, OECD, EEC

	1970–79	1980–89
Growth Rate of GDP (%)		
Greece	5.4	1.5
OECD	3.5	2.8
EEC	3.3	2.1
Consumer Price Inflation (%)		
Greece	12.3	19.5
OECD	8.3	6.1
EEC	9.3	7.0
Current Account (% of GDP)		
Greece	–4.7	–5.1
OECD	–0.1	–0.4
EEC	0.0	0.1
Unemployment Rate (%)		
Greece	2.3	6.6
OECD	4.3	7.5
EEC	3.9	9.9
Growth Business Investment (%)		
Greece	4.9	–0.6
OECD	3.7	4.7
EEC	3.1	3.7

Source: *OECD Economic Outlook*, December 1989.

Table 2
Greece's External Debt and its Servicing
1978–88

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
						Billion US $					
Total External Debt	4.5	5.1	6.4	7.9	9.5	10.6	12.3	15.7	17.1	21.0	20.6
of which Medium & Long Term	3.8	4.1	5.4	6.2	7.3	8.7	9.8	12.8	14.7	19.2	18.4
Total External Debt (% of GNP)	14	13	16	21	24	30	37	47	44	46	40
Debt Servicing (% current receipts)	8	8	9	13	14	16	19	22	22	26	24

Source: *OECD Economic Surveys: Greece* (various issues).

Table 3
Public Sector Deficits, Public Debt and External Debt
Greece, 1979–1989

	1979	1981	1983	1985	1986	1987	1988	1989
PSBR (% of GDP)	5.7	14.3	11.3	17.9	14.0	13.2	16.1	21.5
Public Debt (% of GDP)	27.4	39.7	54.2	76.9	79.4	84.5	91.5	100.0
Internal	21.8	26.9	32.2	40.5	43.0	49.9	58.5	...
External	5.6	12.8	22.0	36.4	36.4	34.6	33.0	...
External Debt (% of GDP)	13	21	30	47	44	46	40	...

Source: *OECD Economic Surveys: Greece* (January 1990)

Table 4
Government Expenditure and its Structure

	1960	1970	1980	1985	1988
Government Consumption (excluding Wages)	3.1	3.4	4.9	6.4	6.8
Government Wage Bill	8.6	9.3	11.4	14.0	13.8
Government Investment	4.8	4.5	2.5	4.0	3.0
Subsidies	0.1	0.8	2.4	3.0	1.6
Social Insurance and Transfers	4.9	7.6	9.0	14.6	15.1
Interest Payments	0.3	0.9	2.4	5.4	8.1
GRAND TOTAL	17.0	22.1	33.2	47.8	49.4

Source: *OECD Economic Outlook* (December 1989).

Table 5
The Tradeoff between Inflation and the Primary Budget Surplus for Public Debt Stabilization at 100% of GDP

"Gloomy" Growth Scenario: $\gamma = 2\%$

Inflation %	Primary Budget Surplus % of GDP	
	$r = 5\%$	$r = 3\%$
0	2.1	0.0
5	0.6	–1.7
10	–0.1	–2.5
15	–0.3	–2.7
20	–0.3	–2.6
25	0.0	–2.4
30	0.3	–2.0
40	1.0	–1.3

"Rosy" Growth Scenario: $\gamma = 4\%$

Inflation %	Primary Budget Surplus % of GDP	
	$r = 5\%$	$r = 3\%$
0	–0.8	–3.0
5	–2.1	–4.5
10	–2.6	–5.1
15	–2.7	–5.2
20	–2.6	–5.0
25	–2.2	–4.6
30	–1.9	–4.2
40	–1.1	–3.4

NOTES: These numbers have been obtained by calibrating the model with the following parameter values: $\delta = 2.5\%$, $\beta = 1.7\%$, $\lambda = 1\%$, $k = 60\%$, $\eta = 5.6$. See the text for a justification of these choices.

Table 6
Tradeoffs among Taxes, Seignorage and External Debt
for Public Debt Stabilization at 100% of GDP

Scenario: $\gamma = 2\%$, $r = 5\%$, $g = 40\%$		
Inflation %	Taxes % of GDP	External Debt % of GDP
5	41	62
15	40	40
25	40	27

NOTES: See notes to the previous Table. The baseline of 40% external debt to GDP ratio at 15% inflation has been assumed to correspond with the actual experience of 1988.

Table M1

Tests for Unit Roots of Money Demand Variables

	Annual Data 1950–88		Quarterly Data 1961 Q2–1989 Q2	
	DF	ADF	DF	ADF
lnM_t	–1.19	–0.23	–	1.45
lnP_t	–	1.29	–	1.34
$ln\Omega_t$	–3.82	–3.09	–	–3.25
i_t	–	–0.87	–0.30	–0.39
Critical Value	2.93	2.93	2.89	2.89

NOTES: M is the narrow money supply M1. P is the GDP deflator (annual data) and the wholesale price index (quarterly data). Ω is GDP at 1970 prices (annual data) and the index of industrial production (quarterly data). i is the period average of the interest rate on savings deposits. DF is the Dickey–Fuller test, ADF is the Augmented Dickey Fuller test and the critical value the 5% value from Fuller (1976). The number of lags included in the ADF regression have been as proposed by Schwert (1987). Given our sample sizes these are one lag for annual data and four lags for quarterly data. The simple Dickey–Fuller test is not reported when the coefficients of lagged changes are statistically significant.

Table M2

Cointegration Tests

	Annual Data 1950–88		Quarterly Data 1961 Q2–1989 Q2	
	DF	ADF	DF	ADF
	–3.30	–2.80	–4.49	–2.94
Critical Value	4.35	3.98	4.22	4.02

NOTES: The DF and ADF test are tests on the residuals of a regression of the log of the money supply on the log of income and prices, and the level of the nominal interest rate. The critical values are from Engle and Yoo (1987).

Table M3

Estimates of Money Demand Functions

Dependent Variable: $\Delta ln(M/P\Omega)_t$

	Annual Data 1952–88		Quarterly Data 1961 Q2–1989 Q2	
	OLS	IV	OLS	IV
Constant	0.03	0.03	0.01	0.01
	(0.01)	(0.01)	(0.01)	(0.01)
Δr_t	–1.99	–5.59	–0.71	–9.89
	(0.90)	(1.84)	(0.81)	(3.95)
s	0.057	0.069	0.048	0.070
DW	2.057	2.100	2.205	2.299

NOTES: The quarterly estimates have been obtained with the addition of 3 quarterly dummies. The instruments used in IV estimation have been one lag of monetary growth, inflation, output growth and the change in the nominal interest rate.

Figure 1

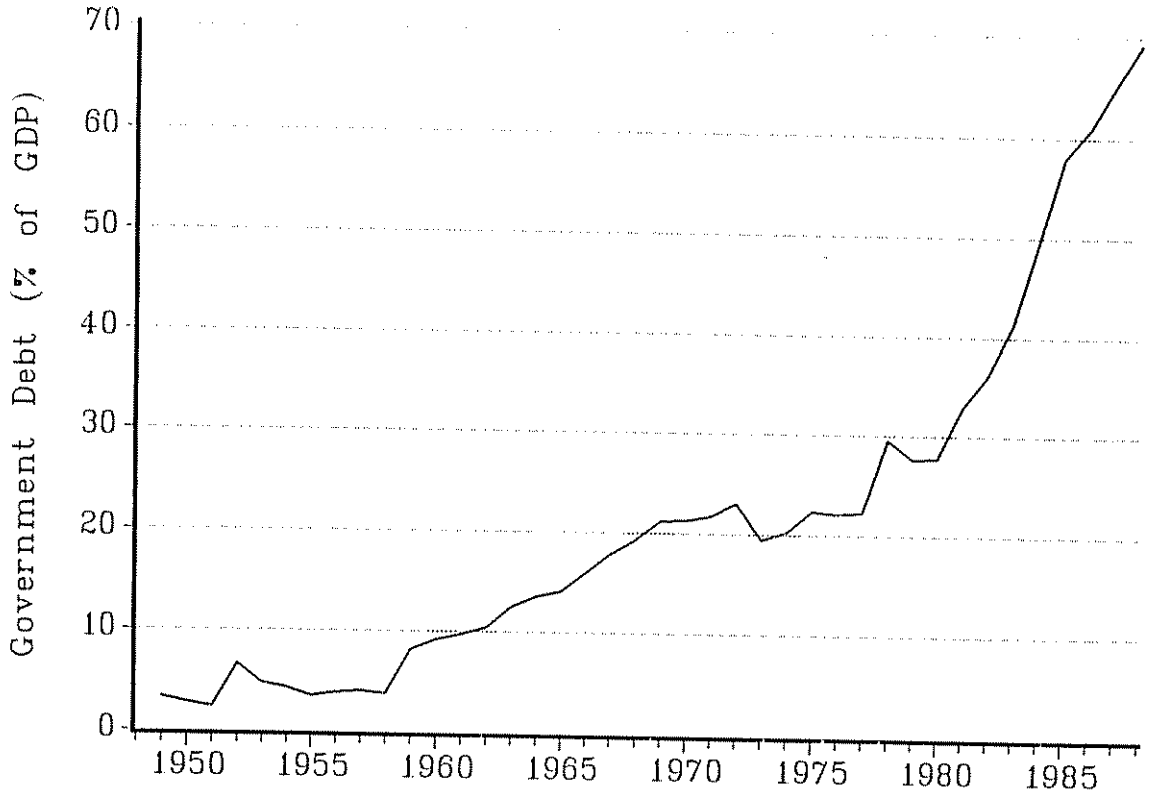
Government Debt (% of GDP)
70
60
50
40
30
20
10
0
1950
1955
1960
1965
1970
1975
1980
1985

Figure 2
Equilibrium Private Consumption and Assets

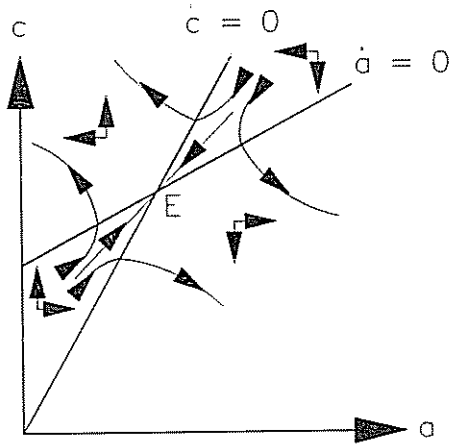

Figure 2a

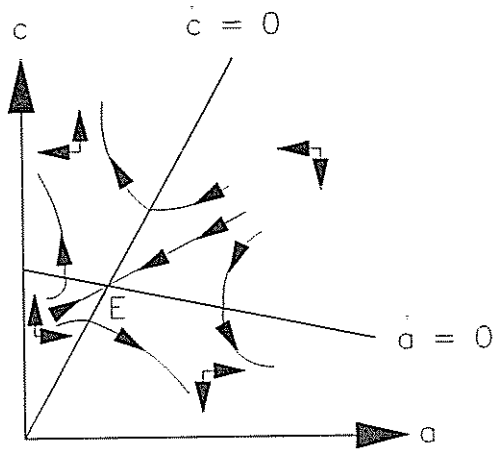

Figure 2b

Figure 3
Equilibrium Private Consumption and Assets

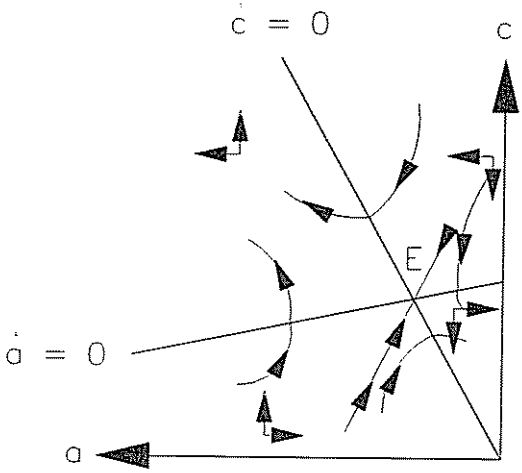

Figure 3a

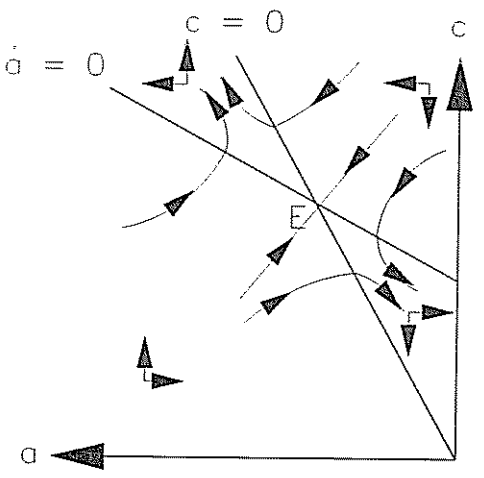

Figure 3b

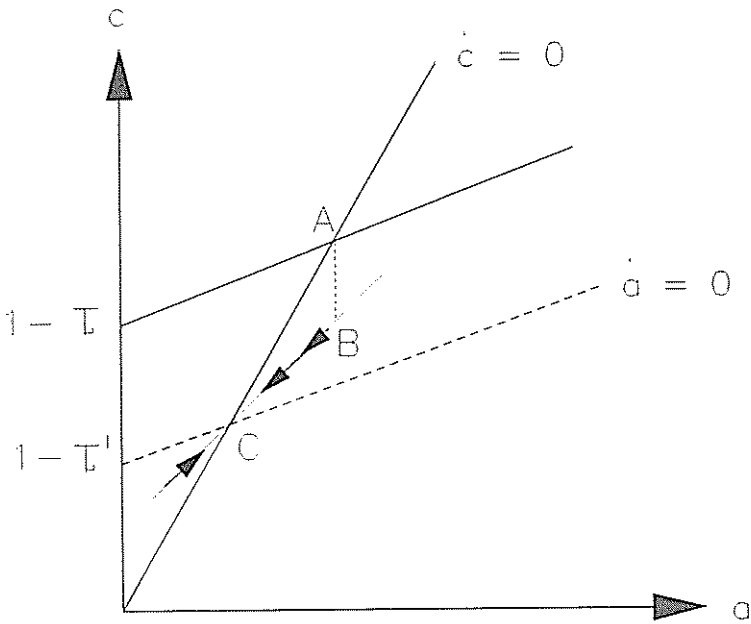

Figure 4
A Tax Financed, Steady State Increase
in the Public Debt/GDP Ratio

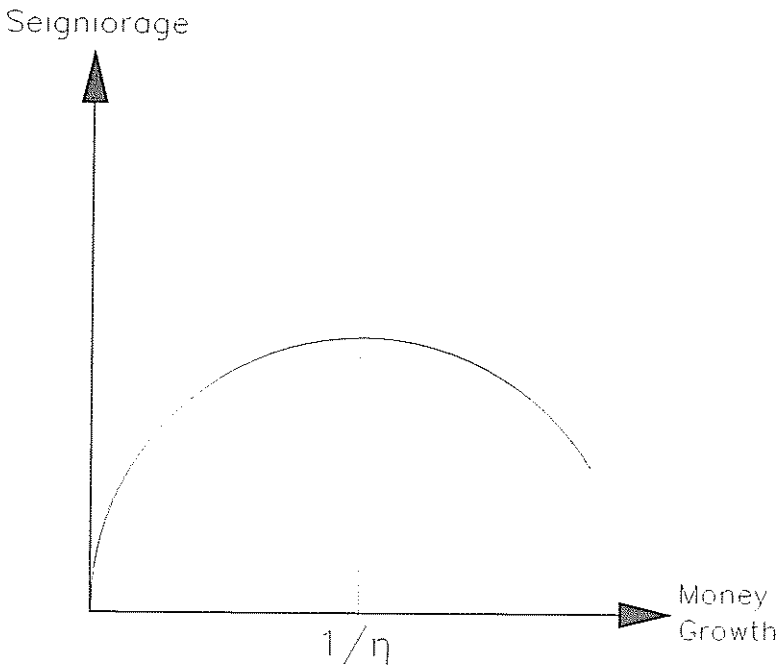

Figure 5

The Seigniorage "Laffer Curve"

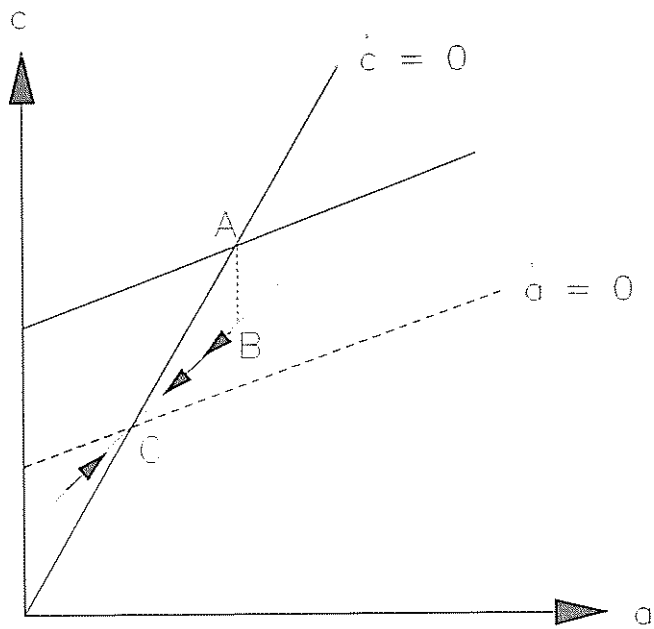

Figure 6
A Seigniorage Financed Steady State Increase
in the Public Debt/GDP Ratio

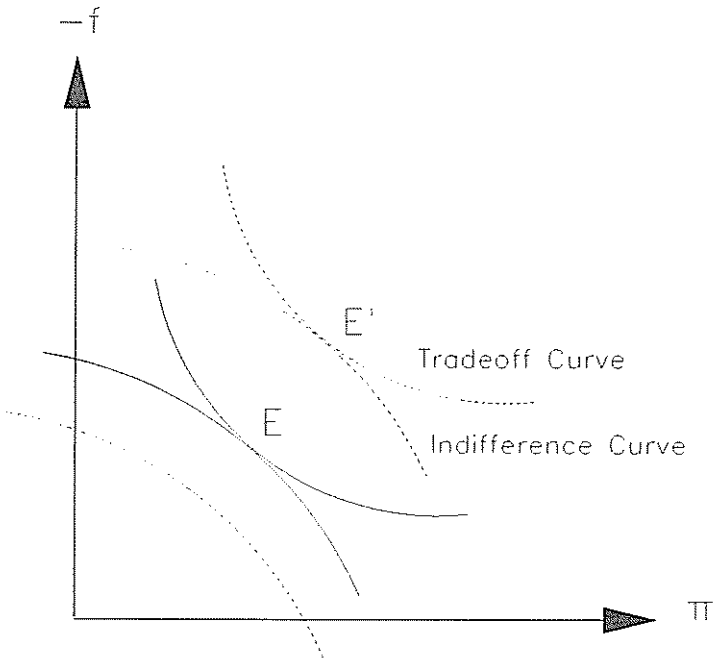

Figure 7

The Tradeoff between Inflation and External Debt