NBER WORKING PAPER SERIES

SEIGNIORAGE IN EUROPE

Vittorio Grilli

Working Paper No. 2778

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
November 1988

Prepared for the Conference "Monetary Regimes and the Setting-up of Monetary Institutions: Issues and Perspectives in Europe," Castelgandolfo, Italy, June 1988. I would like to thank for helpful discussions, Alberto Giovannini, Gabriel de Kock, Guillermo Mondino, and Guido Tabellini. Financial support from the National Science Foundation and the Council for West European Studies is gratefully acknowledged. This research is part of NBER's research program in International Studies. Any opinions expressed are those of the author not those of the National Bureau of Economic Research.

NBER Working Paper #2778
November 1988

SEIGNIORAGE IN EUROPE

ABSTRACT

In this paper, based on the experience of ten European countries, we study the relevance of seigniorage revenues in the recent past, and we speculate about their importance in the near future. We find that the members of the European community differ widely in the way they manage monetary policies. While for some of the European countries we could not identify any consistent seigniorage policy, for others seigniorage appears to have been an important component of their financing policies. This lack of consensus about the role of monetary policies is a potential source of conflict in designing common exchange rate policies.

A formal analysis of the current status of the finances of the governments of the ten European countries also revealed that several of them are now following budget policies that are potentially incompatible with their long run solvency. This also represents a major obstacle toward monetary unification on exchange rate stability. Member countries will be faced with quite different needs for revenues and eliminating a (politically) flexible instrument like siegniorage may result in an unstable situation.

Vittorio Grilli
Department of Economics
Yale University
1972 Yale Station
New Haven, CT 06520

Introduction:

One of the most debated problems in Europe today is the definition of the strategy for achieving monetary integration. The European Monetary System (EMS) was established as an intermediate step toward such unification. The EMS has produced increasing stability in exchange rates, but this success has been facilitated by the existence of widespread capital controls that have discouraged speculative activities. The process of financial liberalization which is now in progress, while certainly beneficial in other respects, could seriously undermine the solidity of the EMS. One of the main reasons for concern is the uneven status of the government finances of the member countries. Exchange rate systems like the EMS impose monetary discipline that may be too tight for countries that are struggling with large public deficits.

The close link between budget decisions and the exchange rate is analyzed in Grilli (1988). There it is shown that the financing of government expenditures may be incompatible with a fixed exchange rate and that, historically, this incompatibility has been one of the main causes of exchange rate crises. According to this point of view, inflation is an essential element of an optimal taxation program. Therefore, waiving the discretionary power over money supply decisions (as implied by a fixed exchange rate system) without, at the same time, surrendering the sovereignty over fiscal policies, may not be a credible arrangement. Similar concerns have been expressed by others, e.g. Dornbusch (1987) and Giavazzi (1987). Dornbusch (1987) suggests that, given the probable existance of large discrepancies in seigniorage needs among the European countries, a more realistic exchange rate arrangement would be a crawling peg. In this system, the rates of depreciation would be set to meet national budgetary requirements.

Whether or not these are critical considerations is ultimately an empirical issue. In particular, it is important to establish whether revenue needs have indeed affected the way in which inflation has been determined in the past, and if they are likely to be important in the future.

In order to address these issues, we first present a simple theory of seigniorage and income taxation, which is related to pioneering work by Phelps (1973), and which has been recently revived by Mankiw (1987), Poterba and Rotemberg (1987) and Grilli (1988), among others. We derive the time series properties of seigniorage and income taxes. It is shown that, if the government behaves optimally, the tax rate and the rate of inflation should be martingale processes. Futhermore, the tax rate and the inflation rate should be cointegrated. We test these implications for ten European countries (Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Netherlands, Spain, and U.K.).

Next, we analyze the effects of three important elements on the results. First, we investigate the consequences of the development of financial markets on the demand for monetary base. Second, we study the constraint imposed on seigniorage policies by the existence of a fixed (semi-fixed) exchange rate system. Finally, in order to evaluate the potential future needs for revenues in general, and seigniorage in particular, we analyze the government budget situation of the ten countries by formally testing for their long run solvency.

2. A Common Argument for Uncommon Currencies: The Inflation Tax[1]

2.1 A Simple Closed Economy Model of Optimal Seigniorage

For an exchange rate system to be reasonably stable it is necessary that the inflation rates of the participating countries do not diverge in the long run. Therefore, it is important to understand the criteria according to which monetary growth is determined in the various countries, and if they imply converging rates of inflation. Table 1 presents the average rates of inflation in selected sub-periods since 1950 for the ten European countries. The average rate of inflation has increased in all of the countries after the collapse of the Bretton-Woods system. In the period of flexible exchange rates between 1971 and 1978 the rate of inflation has been, on average, highest. While in the Eighties the rate of inflation has been, on average, lower than in the Seventies, the cross-country variance has been the highest. Why is inflation diverging across the countries, and is this pattern likely to continue?

There are several ways of modelling the process that generates inflation. In the most popular models the authorities, following a Phillips curve inspired policy, try to use inflation for stabilization purposes. More recently, game theoretic applications of this idea, initiated by Barro and Gordon (1983), have pointed out that, if the authorities cannot credibly commit to time inconsistent policies, the equilibrium will be characterized by high (sub-optimal) rates of inflation. Since the equilibrium inflation rate depends on the particular structure of the economy and on the objective function of the authorities, this approach could potentially explain cross-country differences in inflation.

A different but not necessarily alternative approach investigates the potential connection between inflation and government financing decisions. This way of looking at the problem, while not novel, has recently received renewed attention, perhaps because budgetary problems have become the central issue in the policy debate. According to this approach, the proper way of looking at inflation is from a public finance point of view. Money creation is a source of revenues (seigniorage) for the government. One important reason for inflating the economy (the most important according to this approach), is to finance the primary deficit. To understand inflation we have to analyze the behavior of budget variables, like expenditure and other sources of revenues (taxes). Table 2 presents the average government expenditure-output ratios for selected periods. As was the case for inflation, expenditure has increased on average in all of the countries after 1970. Also, in the Eighties, both the average expenditure-output ratio and its cross country variance has been higher than in the Seventies. These figures seem to be compatible with a public finance-oriented explanation of inflation. In order to construct a more formal way of testing the validity of this theory, we present a simple benchmark model, close in spirit to the work on optimal inflation tax by Phelps (1973), and which has been recently used by Mankiw (1987) and Grilli (1988).

The basic structure of the model is straight forward. The government's problem is to choose the optimal mix of distortionary taxes and deficit to finance an exogenous and stochastic stream of expenditure. Formally, the problem can be expressed as:

$$\text{P-1} \quad \min_{T_t, S_t} E_t \sum_{j=0}^{\infty} \left[\frac{1}{1+r}\right]^j \left\{C_1(T_{t+j}) + C_2(S_{t+j})\right\}$$

$$\text{s.t.} \sum_{j=0}^{\infty} \left[\frac{1}{1+r}\right]^j \left\{T_{t+j} + S_{t+j}\right\} = \sum_{j=0}^{\infty} \left[\frac{1}{1+r}\right]^j G_{t+j} + (1+r) B_{t-1}$$

where r is the (assumed) constant real interest rate, T_t are income tax revenues (at time t), G_t are real government expenditures, B_t is real government debt, S_t is seigniorage. $c_1(\cdot)$ and $c_2(\cdot)$ are convex functions, which model the potential welfare loss associated with income taxation and inflation, respectively. The costs of income taxation are associated with its distortionary effects on labor supply and with the administrative costs of collection. The costs of raising seigniorage are related to the distortionary effects of inflation. These potentially involve both reductions in desired cash holdings (and the consequent negative effects transactions) and unwelcome redistributive effects.[2] It is assumed that the government selects T_t and S_t in order to minimize the expected present discounted value of the distortions introduced by taxation. This type of model produces the tax smoothing result obtained by Barro (1979). Taxes (both income tax and inflation) are set on the basis of permanent government expenditure, with temporary deviations from this level being financed by issuing debt.

Even if not evident from the way we formulated the problem, the optimal policy implied by P-1 may not be time consistent. As originally pointed out by Calvo (1978), the difficulty arises because inflation may be distortionary ex-ante, but not ex-post. This will be the case, for example, if the only costs associated with inflation are its negative effects on (forward looking) money demand. Ex-post, i.e. after individuals made their decisions about their cash holdings, the monetary authorities may deviate from the "ex-ante optimal" rate of inflation, thus increasing seigniorage without inducing a reduction in cash holdings. In the rest of this paper we will be discussing the properties of the optimal policy, without explicitly addressing time consistency issues. This simplification, however, is not crucial to the analysis. First, for some of the countries under consideration, credibility of the monetary authorities is not a serious issue. Second, as it has been recently shown by Persson, Persson and Svensson (1987), there exist very simple schemes that may resolve the basic time inconsistency problem for this class of models. Third, and most important, Poterba and Rotemberg (1987) have shown that, if the costs of inflation also involve ex-post components (as in the case of redistribution effects), the time consistent solution has basically the same time series properties as the one we will be discussing below.

If we make the simplifying assumption that the two cost functions are quadratic in T_t and S_t, i.e.

$$c_1\ (T_t) = (a_1 + \frac{b_1}{2} T_t^2) \tag{2.1}$$

$$c_2\ (S_t) = (a_2 + \frac{b_2}{2} S_t^2) \tag{2.2}$$

the first order conditions of P-1 imply:

$$E(T_{t+1}) = T_t \tag{2.3}$$

$$E(S_{t+1}) = S_t \tag{2.4}$$

The first implication of the theory is that income tax revenues and seigniorage should be martingale processes, independently of the process generating government expenditure. This is, of course, a result analogous to the random walk property of consumption derived by Hall (1978). Notice that the first order conditions imply a linear relationship between seigniorage and tax revenues:

$$S_t = \frac{b_1}{b_2} T_t \tag{2.5}$$

Quite intuitively, the relative importance of seigniorage in an optimal taxation package depends positively on the cost of using income taxes (b_1) and negatively on the cost of using monetization (b_2).

The model also produces a positive relationship between revenues and expenditures. By taking the expectation operator, E_t, across the budget constraint, and substituting the first order conditions:

$$E_t T_{t+j} = \frac{\lambda}{b_1};\ E_t S_{t+j} = \frac{\lambda}{b_2}$$

(where λ is the Lagrange multiplier associated with the intertemporal budget constraint) we obtain:

$$T_t = \frac{b_2}{b_1+b_2} \left[\left[\frac{r}{1+r}\right] \sum_{j=0}^{\infty} \left[\frac{1}{1+r}\right]^j E_t\ G_{t+j} + rB_{t-1} \right] \tag{2.6}$$

$$S_t = \frac{b_1}{b_1+b_2} \left[\left[\frac{r}{1+r}\right] \sum_{j=0}^{\infty} \left[\frac{1}{1+r}\right]^j E_t\, G_{t+j} + rB_{t-1} \right] \tag{2.7}$$

By making explicit assumptions about the stochastic process driving expenditure, G_t, we can derive from (2.5) and (2.6) expressions for T_t and S_t which are functions of observables only. For example, under the assumption that G_t is a random walk, we obtain:

$$T_t = \frac{b_2}{b_1+b_2} \left[G_t + r\, B_{t-1}\right] \tag{2.8}$$

$$S_t = \frac{b_1}{b_1+b_2} \left[G_t + r\, B_{t-1}\right] \tag{2.9}$$

Taxes and seigniorage are constant proportions of expenditure inclusive of interest payments. If we introduce an additive random error in the theoretically exact relationships (2.5), the stochastic implication of this theory is that S_t and T_t must be cointegrated, with the constant of integration being a measure of the relative cost of income tax and seigniorage. A similar argument holds for the expressions (2.8) and (2.9) which imply that taxes and seigniorage must be cointegrated with government expenditure (inclusive of interest payments). Notice that, in this special case, since all shocks to G_t are perceived to be permanent, the fiscal authorities will never issue any new debt. However, the properties derived above do not depend on the assumption that G_t is a random walk. Government expenditure may follow a more general non-stationary process of the form:

$$G_t = G_{t-1} + \sum_{j=0}^{I} b_j \epsilon_{t-j}$$

and the same cointegration property would still hold.[3] In this (more general) case, government debt will have a role.

It can be argued that a more appealing way to model the distortionary effect of taxation and the choice of policy instruments is not in terms of total income tax and seigniorage, but in terms of the income tax rate and the rate of inflation. This can be done by properly respecifying the model. For example, assume that the cost functions have the form:

$$c_1(T_t) = (a_1 + \frac{b_1}{2} \tau_t^2)\, Y_t \tag{2.10}$$

$$c_2(S_t) = (a_2 + \frac{b_2}{2} \pi_t^2)\, Y_t \tag{2.11}$$

where τ_t is the (average) income tax rate and π_t is the inflation rate.

We can reformulate P-1 as:

$$\text{P-2} \quad \min_{\tau_t, \pi_t} E_t \sum_{j=0}^{\infty} \left[\frac{1}{1+r}\right]^j \left[\left[a_1 + \frac{b_1}{2} \tau_{t+j}^2\right] Y_{t+j} + \left[a_2 + \frac{b_2}{2} \pi_{t+j}^2\right] Y_{t+j}\right]$$

$$\text{s.t.} \quad \sum_{j=0}^{\infty} \left[\frac{1}{1+r}\right]^j \left[\tau_{t+j} Y_{t+j} + \pi_{t+j} m_{t+j}\right] = \sum_{j=0}^{\infty} \left[\frac{1}{1+r}\right]^j G_{t+j} + (1+r)B_{t-1}$$

where m_t are real cash balances and we have used $\pi_t m_t$ as a measure of seigniorage.[4] If we assume that money demand is a constant fraction of output: $m_t = m y_t$ we obtain:

$$\pi_t = \frac{b_1 m}{b_2} \tau_t \tag{2.12}$$

This model, therefore, predicts that τ_t and π_t must be cointegrated. Also, it is approximately true that:[5]

$$\tau_t = \frac{b_2}{b_1 m^2 + b_2} \frac{G_t + rB_{t-1}}{y_t} \tag{2.13}$$

$$\pi_t = \frac{b_1 m}{b_1 m^2 + b_2} \frac{G_t + rB_{t-1}}{y_t} \tag{2.14}$$

The tax rate and the rate of inflation should be cointegrated with government expenditure (inclusive of interest payments) expressed as a fraction of output. Note, also, the effect of the velocity of money on seigniorage and income taxation. Countries with low velocity (high m) will find it optimal to have a relatively high rate of inflation.

As pointed out by Mankiw (1987), allowing for the velocity to be a function of inflation would not change the basic results. In particular, the positive correlation between seigniorage and taxes would still be present. Suppose, for example, that $m_t = (\alpha - {}^{\beta}/_{2}\pi_t)\ y_t$. Then, from the first order conditions of P-2 we derive:

$$\pi_t = \frac{b_1 \tau_t}{b_2 + \beta b_1 \tau_t}$$

which implies that $\frac{d\pi_t}{d\tau_t} > 0$.

2.2 Empirical Evidence

Results from Previous Analysis

The insight that, in an environment like the one described above, the inflation rate and the tax rate should be positively correlated, is the basic idea behind recent analyses by Mankiw (1987), and Poterba and Rotemberg (1987). Mankiw (1987) argues that the theory of optimal seigniorage performs reasonably well in explaining the behaviour of nominal interest rates and inflation in the postwar United States. His conclusion is based on the finding that the inflation rate (and the nominal interest rate) and the average tax rate are indeed positively correlated, and that the regression coefficients are significant, on the basis of the standard T-statistics. Poterba and Rotemberg (1987), on the other hand, raise some doubts about the generality of the theory. They extend Mankiw's analysis to Japan, Germany, France and the U.K., and they find that a significant positive correlation is present only in the Japanese data.

A fundamental problem with both analyses is that they do not take into consideration the full range of empirical implications of the theory. They look only for a positive correlation between inflation and tax rate, but they do not inquire about their unit root and cointegration properties. More importantly, the very nature of these properties, i.e. the fact that inflation and taxes should have a unit root, may invalidate the kind of tests used in those papers. It is well known, in fact, that standard regression techniques cannot be used in presence of non-stationary variables. In general, the standard T-statistics do not have a limiting distribution and cannot be used to test the significance of regression coefficients. In this case, the proper approach is to test for the existence of cointegration among the non-stationary variables. We refer the reader to Engle and Grenger (1987) for a discussion of the topic.

Our empirical analysis proceeds in two steps. First, we test whether the various measures of seigniorage and income taxes have a unit root, a necessary condition if a country is behaving according to the simple theory outlined above. Second, we test for the existence of cointegration among revenue variables and between revenues and expenditures. All the data are drawn from the International Monetary Fund International Financial Statistics, and are all in logarithms. The sample size varies across countries, and it is the longest possible in the period 1948-1986. Consequently, it varies from a maximum of 38 observations (for Ireland and the U.K.) to a minimum of 22 (for Spain). For all the other countries it is between 30 and 35 observations. Expenditure and revenue data have been expressed in real terms using the GDP deflator of the respective country. In the Appendix we provide a more detailed description of the data sources.

Unit Root Tests

We conducted a variety of unit root tests, including tests proposed by Dickey and Fuller (1979), Dickey and Fuller (1983), Phillips (1987) and Phillips and Perron (1987). Since the results of the different tests were very similar, we report only the Z_a (Phillips (1987), the Z_μ and Z_τ (Phillips and Perron (1987)) tests, which are presented in Table 3, Table 4 and Table 5. The basic difference between the three tests is that the Z_a test is designed for a pure autoregressive process, the Z_μ for an autoregressive process with a drift, and Z_τ for an autoregressive process with a drift and time trend. The exact form of the null hypotheses and of the alternatives for these tests are given at the bottom of the tables.

Table 3 tests for the existence of a unit root in the total tax revenues and average tax rate series. The results of the same test for the total government expenditure and the expenditure/GDP ratio (g_t) series, are reported in Table 5. Not surprisingly, for all the countries both G_t and g_t are non-stationary in the sample periods. For Greece, the existence of a unit root in G_t is rejected against the alternative of a linear time trend at a more than 97.5% confidence level. The same general non-stationarity is true for T_t and τ_t. A notable exception is the U.K., for which the average tax rate appears to be stationary.

Table 4 presents the same battery of tests for total seigniorage, and inflation. The unit root hypothesis for π_t is never rejected when the alternative is a pure autoregressive process. The rejection is instead possible at the 99% confidence level for Ireland, Italy and the Netherlands when the althernative includes a drift, or a drift and a time trend. At a lower confidence level, rejection is also possible for Germany, which, in a sense, confirms the result by Poterba and Rotemberg (1987). Similar results hold for S_t: rejection of non-stationarity is possible for Denmark, Ireland, Italy and the Netherlands.

Summarizing, as far as seigniorage is concerned, the evidence is somehow mixed. Specifically, Ireland, Italy, the Netherlands, and possibly Germany and Denmark, may not be satisfying the unit root condition. The unit root implication for the income tax rate receive wider support: only the U.K. may be violating this condition. Finally, the assumption of unit root processes for government spending, made to derive the cointegration property between revenues and expenditure, is strongly supported by the data.

Cointegration Tests

In this section we test for the existence of cointegration between siegniorage (inflation) and expenditures, and seigniorage (inflation) and taxes. Given the results of the unit root tests, including Denmark, Ireland, Italy, Germany and the Netherlands in the analysis may not be appropriate. However, it is interesting to know whether the inflation rate and the tax rate have moved in the same direction, even if this finding may not be considered evidence that seigniorage was used in an efficient way. In fact, even if taxes are globally set at suboptimal levels, it could be the case that the relative weights of the different tax instruments are still choosen according to the above theory. For example, if a government decides, (for reasons exogenous to our model) to set the taxes at levels lower than what would be necessary to satisfy its budget constraint, the inflation rate and the income tax rate could be displaying a stationary behavior. Nonetheless, if it is using inflation for revenue purposes, it may still find it desirable to move the inflation rate and tax rate together. Moreover, the unit root tests used above, as well as the cointegration tests that we will be using below, are all asymptotic tests. Therefore, given the small sample size, the margin of error may be bigger than the one based on asymptotic distributions.

In Table 6 we present the results of regressing total seigniorage on total taxes, and total seigniorage on total government expenditure (inclusive of interest payments). Table 7 presents analogous results based on the inflation rate, the tax rate and the expenditure rate. Finally, Table 8 reports the results of regressing total taxes on total expenditure, and the tax rate on the expenditure rate. Following the suggestion by Engle and Granger (1987), the cointegration tests are based on the

Augmented Dickey-Fuller test (ADF). The critical values of the ADF test are based on Phillips and Ouliaris (1987), where they derive the asymptotic distribution of the test for a different number of right-hand variables.

Notice first, that the positive correlations between seigniorage and taxes, seigniorage and expenditure, and taxes and expenditure are present for all the ten countries. Also, on the basis of the standard T-statistics, these correlations are very significant. The same is true for the correlations between inflation rate, tax rate, and expenditure rate. However, we should be cautious in interpreting these statistics when non-stationary variables are involved. Even if these variables moved in the same direction in the post World War II period, the ADF test rejects the hypothesis of cointegration for several of the countries.

On the basis of these tests, we can divide the ten countries into two groups. The countries composing the first group, (Belgium, Denmark, the Netherlands, Spain and the U.K.), do not show evidence of cointegration in any of the regressions. However, the second group, (France, Germany, Greece, Ireland and Italy), provides partial support to the theory. Given that the regression residuals for the countries for this second group are stationary, we can be more confident about the meaningfulness of the relationships among revenue variables and between revenue and expenditure variables. It is possible, however, that the stationarity of the residual of the seigniorage regressions for Ireland, Italy or Germany, is simply a consequence of the fact that the dependent variable is, indeed, stationary.

The evidence in this second group, even if more favorable, is not homogeneous. In general, the hypothesis of cointegration between taxes and expenditure receives less support than the cointegration between seigniorage and expenditure. The result that income taxes have not been cointegrated with expenditure is a surprising and worrying result. It can be argued, in fact, that inflation has been used for purposes other than seigniorage, and this is responsible for the lack of cointegration with expenditure. This argument, however, is much less convincing in the case of other sources of revenue. The lack of this long run relationship between expenditure and taxes raises the question of whether the current budget policies are compatible with long run government solvency. We will investigate this problem later on in the paper. Another characteristic that emerges from the analysis is that the regressions based on total seigniorage receive more support than ones based on the rate of inflation. This is particularly true for Greece and Italy.

Once again, the empirical evidence is mixed. For some countries, seigniorage has been an important revenue instrument, while, for others, there was no consistent inflation tax policy. These results are a cause for concern because they indicate that there exists a lack of homogeneity in the role of monetary policies among European countries. This is a potential source of conflict, especially in forming a common exchange rate policy.

These conclusions are based on a simple benchmark model. In the following section we point out the most important simplifications and discuss the possible implications of these hypotheses.

3. Extensions of the Model

3.1. Variability in Velocity and in the Cost Functions

The above analysis assumed, in common with Mankiw (1987), that velocity is fixed over time. Changes in velocity, however, might affect the desirability of seigniorage as a source of revenue. In general, in fact, it is optimal to have a higher level of seigniorage in periods of low velocity. Ignoring these movements in velocity may introduce bias in the estimates. For example, increases in seigniorage induced by increases in expenditure might have been offset by decreases induced by increases in velocity. In equation (2.12), for example, this is equivalent to a decrease in m.

As Table 9 shows, important changes in velocity occurred during the period under investigation. Two distinct patterns emerge. A first group of countries (Belgium, Denmark, France, the Netherlands and the U.K.) has experienced a pronounced decrease in the ratios of monetary base to output. We believe that this tendency is the consequence of the innovations in the financial markets that greatly reduced the use of monetary base in transactions in the last 30 years. The other group, (composed of Germany, Greece, Ireland, Italy and Spain), does not show the same negative trend. On the contrary, Spain and Greece exhibit, if anything, a positive trend.

What is interesting is the almost identical composition of these two groups and the groups based on the cointegration results. With the exception of France, the countries that experienced a strong positive trend in velocity are also the ones for which the cointegration properties are absent. Similarly, the countries for which the evidence of cointegration was stronger, are also the ones (with the exception of Spain) in which the ratio of monetary base and output remained relatively high.

It is likely that the increase in velocity has induced a shift in the seigniorage policies of those countries, with inflation tax losing much of its importance. In addition to the recent developments in the financial markets, other factors contributed to the diverse behavior of velocity among the European countries. Giavazzi (1987) suggests that government policies, by altering the reserve requirements of the commercial banks, had a major impact on the demand for monetary base. In fact, Greece, Spain, Italy and Germany are the countries that, in 1986, had the highest reserves-to-deposit ratio.[6] These differences in reserve requirements are possible, at the moment, because of the existence of capital controls which reduce the international competition among commercial banks. The unifications of the European capital markets, however, will require the harmonization of these regulations. At that point, the use of seigniorage will be greatly compromised. Another strong hypothesis that is used to obtain the relationship between seigniorage and taxes like (2.5) or (2.12), is that the cost functions $c_1(\cdot)$ and $c_2(\cdot)$ have been assumed to be constant over time. While it is difficult to model the way in which these cost functions may have changed, we cannot rule out this possibility. By inducing shifts between the use of seigniorage and the use of income taxation, the occurrence of changes in the relative costs of the two tax instruments tends to reduce the significance of the (positive) relationship linking them. Moreover, if the process driving the relative cost (e.g. b_1/b_2 in equation (2.5)) has a unit root, then by estimating it with a constant we will be introducing a non-stationary component in the residual. This will lead to a failure to detect cointegration between seigniorage and income tax revenues. A similar argument applies to equation (2.12) with the addition that velocity (1/m) might also have been a unit root process.

3.2. Seigniorage vs. Fixed Exchange Rates

In our basic model, we implicitly assumed that the monetary authorities were potentially free to choose any level of seigniorage.

This approach, however, fails to consider a crucial element in the monetization decisions, i.e. the exchange rate regime. In fact, a fixed exchange rate system imposes serious constraints on the ability of governments to independently set the level of inflation. Given that a country values a stable exchange rate, it may be willing to suffer the cost of a suboptimal use of the inflation tax. These are important considerations since most of the observations in our data set refer to periods of fixed or controlled exchange rates: Bretton-Woods first and the EMS later on.

A simple way to model this idea is to introduce into the government loss function an additional term which penalizes the variance of inflation (around the mean level of the system or around the level of a leader country). We may think of this as the costs associated with devaluations and switches to flexible exchange rates and with the resulting increase in volatility of the real exchange rate. We can rewrite the fiscal authority problem as:

$$\text{P-3} \quad \min E_t \sum_{j=0}^{\infty} \left[\frac{1}{1+r}\right]^j \left[\left[a_1 + \frac{b_1}{2} \tau^2_{t+j}\right] Y_{t+j} + \left[a_2 + \frac{b_2}{2} \pi^2_{t+j}\right] Y_{t+j} + \frac{b_3}{2} \left[\pi_{t+j} - \pi^*_{t+j}\right]^2 Y_{t+j} \right]$$

$$\text{s.t.} \quad \sum_{j=0}^{\infty} \left[\frac{1}{1+r}\right]^j \left\{ \tau_{t+j} Y_{t+j} + \pi_{t+j}\, m\, Y_{t+j} \right\} = \sum_{j=0}^{\infty} \left[\frac{1}{1+r}\right]^j G_{t+j} + (1+\tau) B_{t-1}$$

where π^*_t is the inflation rate in the leader country in the system (e.g. US before 1971 and Germany after 1979). From the first order conditions, it is easily obtained:

$$\pi_t = \frac{b_1 m}{b_2+b_3} \tau_t + \frac{b_3}{b_2+b_3} \pi_t^*$$

The larger the cost of deviating from π_t^*, the smaller the correlation between π_t and τ_t. In the limiting case of $b_3 \to \infty$: $\pi_t = \pi_t^*$. It is clear that unless b_3 is very small, we may introduce a serious bias if we omit π_t from the regression.

Table 10 reports the results of adding the inflation rate of the leader country as an explanatory variable. π_t^* was chosen to be the US inflation rate up to 1971, except for Ireland where U.K. inflation was used for the whole sample. After 1971, π_t^* was switched to be the German inflation rate, except for Greece and Spain for which US inflation rate was still used. Also, it is important to verify that, for the U.S., the inflation rate has a unit root. If U.S. inflation were stationary, we would not have any hope to induce stationarity in the residuals by adding it as a regressor. Tests analogous to the one performed in the previous sections could not reject the unit root hypothesis. Cointegration is accepted for France, Germany, Ireland, Italy, and the U.K., suggesting that, for these countries, the exchange rate system may have been a serious constraint to the seigniorage policies. In this respect, the experience of Germany and the U.K. is very revealing. In both cases, the positive correlation between seigniorage and taxes disappears. This can be interpreted as an indication of the priority of exchange rate policies over seigniorage policies in these two countries.

4. Is Mr. Ponzi Really Dead? Solvency and Fiscal Reforms

Suppose that, regardless of the results obtained in the previous sections, we believe that seigniorage has not played, at least since the 50's, any significant role in the conduct of monetary policies in Europe. Could we then conclude that seigniorage is not a serious threat to exchange rate stability and to the existence of the EMS? A problem with this point of view is that it neglects to consider the current status of the various governments' finances in the Community. Many economists believe that several of the countries in our sample are not following fiscal policies which are sustainable in the long run. Sooner or later these countries will have to undertake budget adjustments which may well involve resorting to seigniorage revenues. While it is true that inflation does not need to be part of a fiscal reform, the existence of domestic political constraints on the use of alternative sources of revenues may make seigniorage indispensable.

In this section we present results of econometric tests designed to determine whether the idea that some European countries are following potentially insolvent fiscal policies, is indeed founded.

Consider the government budget constraint at time T+1:

$$B_{t+1} = (1+r)\, B_t + G_{t+1} - R_{t+1} \qquad (3.1)$$

where R_{t+1} are total revenues (i.e. taxes plus seigniorage). Taking the expectations at time t, and by recursive substitutions, we obtain:

$$B_t = - E_t \sum_{j=0}^{\infty} \left[\frac{1}{1+r}\right]^j \left[G_{t+j} - R_{t+j}\right] + \lim_{j\to\infty} E_t \left[\frac{1}{1+r}\right]^j B_{t+j} \qquad (3.2)$$

In order for the budget constraint to hold, it must be true that:

$$\lim_{j\to\infty} E_t \left[\frac{1}{1+r}\right]^j B_{t+j} = 0 \qquad (3.3)$$

This is the usual condition which says that the stock of debt cannot increase faster than the government borrowing rate. Condition (3.3) implies, as noted by McCallum (1984), and Hamilton and Flavin (1986), that a constant deficit inclusive of interest payments is consistent with intertemporal solvency. In this case, in fact:

$$B_{t+j} = (j + t)K + B_0 \qquad (3.4)$$

where K is the constant size of the deficit, so that condition (3.3) is satisfied. Hamilton and Flavin (1986) test the intertemporal budget constraint for the U.S. in the period 1962-84. Using a deterministic bubble test of the kind proposed by Flood and Garber (1980), they conclude that the US "government budget historically has been balanced in expected present value terms" (p. 809).

More recently, Trehan and Walsh (1987) have employed a similar test, closer in spirit to the ones employed in the previous sections of this paper. The intuition behind this test is quite simple. The condition of a constant deficit (inclusive of interest payments) is extended in a stochastic environment to the one of the deficit being a stationary variable. More specifically, suppose that the vector $z_t = (G_t \ R_t)$ follows a process given by:

$$(1 - L)z_t = \alpha + A\ (L)\ \epsilon_t \tag{3.5}$$

where L is the lag operator, α is a vector of constants, A(L) is a 2x2 matrix of polynomials in L, and ϵ_t is a vector of white noise innovations. The process (3.5) implies that, consistent with our data, G_t and R_t must be differenced once in order to induce stationarity. Under this condition, Trehan and Walsh (1987) show that the necessary and sufficient condition for the budget to be intertemporally balanced is that the first difference of the stock of debt, i.e. the deficit inclusive of interest payments, is stationary. They also test this condition for the U.S., on a longer sample than Hamilton and Flavin (1986), and they reach the same conclusion.

Table 11 presents the unit root tests for the deficits of the ten European countries. The non-stationarity of the deficit is rejected only for the U.K. and, at a lower level of confidence, for Germany and possibly Denmark. For the other countries, this analysis suggests that the current budget policies will have to be revised if intertemporal balance has to be guaranteed. Even if, given the small sample size, these results should be interpreted with caution, they definitely indicate that for some of these countries the temptation to repudiate their European commitments, even by reintroducing controls on the capital markets or by abandoning the defense of their exchange rate parity, may become very strong.

Conclusions and Policy Implications

In this paper, based on the experience of ten European countries, we tried to understand the relevance of seigniorage revenues in the recent past, and speculate about their importance in the near future. A first conclusion is that the members of the European Community differ widely in the way they manage monetary policies. At a first level of approximation, we divided the countries into two groups. For the first group, composed of Belgium, Denmark, the Netherlands, Spain and the U.K., we could not identify a consistent seigniorage policy. However, for the countries of the second group (France, Ireland, Italy, Germany and Greece), seigniorage appears to have been an important component of their financing policies. This lack of consensus about the role of monetary policies is a potential source of conflict in designing common exchange rate policies.

A formal analysis of the current status of the finances of the governments of the ten European countries revealed that several of them are now following budget policies that are potentially incompatible with their long run solvency. This also represents a major obstacle toward monetary unification on exchange rate stability. Member countries will be faced with quite different needs for revenues and eliminating a (politically) flexible instrument like seigniorage may result in an unstable situation. This problem is likely to become more acute in the near future since, with the dismantling of capital controls, other forms of taxation which intrinsically depended on the segmentation of capital markets, will have to disappear. In the periods of social conflict which are likely to characterize times of fiscal reforms, the temptation to resort to seigniorage and thus either reintroduce capital controls or abandon the exchange rate parity, may become very strong.

What is going to be the future of the exchange rate system in Europe? In what direction should we move? One possibility is the return to a free float. Recent experience, however, has generated widespread skepticism about the desirability of such an arrangement. There exists a fear that movements of the nominal exchange rate are dominated by speculative bubbles, and thus that they may induce market responses that are unrelated to economic fundamentals. It is contended that a higher exchange rate variability may also induce inefficiencies in the allocation of resources. McKinnon (1988), for example, argues that in a world where markets are highly incomplete, forward markets alone cannot provide sufficient insurance against exchange rate risk, especially for long term irreversible investments. But, more fundamentally, a return to a free float is in contradiction with the goal of a European monetary unification.

Another extreme possibility is the switch to an irrevocable fixed exchange rate system. At the moment, however, there do not seem to exist the proper conditions for a tightening of the EMS bands and for the implementation of a strictly fixed exchange rate system. During the next few years, the top priority of several member countries will be the correction of their public finances. This will probably involve major adjustments in their fiscal and monetary policies.

Practicable fiscal adjustments may require several realignments in the exchange rate parities. This, however, need not to imply the end of the EMS. What is important is that these realignments occur without major speculative activities which may interfere with a smooth processes of integration. A way to guarantee the flexible management of the EMS, even in the absence of capital controls, has been suggested by Grilli and Alesina (1987). This would involve the expansion of the inter-country credit facilities and the formal commitment to large short term loans to central banks who come under the danger of a speculative attack.

References

Calvo, G., 1978, "On the Time Consistency of Optimal Policy in a Monetary Economy," Econometrica.

Dornbusch, R., 1987, "The EMS, The Dollar and the Yen," unpublished manuscript.

Drazen, A., 1985, "A General Measure of Inflation Tax Revenues," Economic Letters.

Engle, R.F. and C.W.J. Grenger, 1987, "Co-integration and Error Correction: Representation, Estimation and Testing," Econometrica 55, 251-276.

Flood, R and P. Garber, 1980, "Market Fundamentals Versus Price Level Bubbles: The First Tests," Journal of Political Economy.

Giavazzi, F., 1987, "The Exchange-Rate Question in Europe," unpublished manuscript.

Grilli, V., 1988, "Fiscal Policies and the Dollar/Pound Exchange Rate: 1870-1894," NBER Working Paper no. 2482.

Grilli, V. and Alesina, A., 1987, "Avoiding Speculative Attacks on EMS Currencies: A Proposal." Economic Growth Center Discussion paper No. 547.

Hamilton, J. and M. Flavin, 1986, "On the Limitation of Government Borrowing: A Framework for Empirical Testing," American Economic Review.

Mankiw, N.G., 1987, "The Optimal Collection of Seigniorage: Theory and Evidence," Journal of Monetary Economics.

McCallum, B., 1984, "Are Bond-Financed Deficits Inflationary? A. Ricardian Analysis," Journal of Political Economy.

McKinnon, R., 1988, "Monetary and Exchange Rate Policies for International Financial Stability: A Proposal," Journal of Economic Perspective.

Mundell, R., 1973, "Uncommon Arguments for Common Currencies," in H. Johnson and A. Swoboda (eds.), The Economics of Common Currencies, George Allen and Unwin.

Persson, M., Persson, T. and L. Svensson, 1987, "Time Consistency of Fiscal and Monetary Policy," Econometrica.

Phelps, E., 1973, "Inflation in the Theory of Public Finance," Swedish Journal of Economics.

Phillips, P.C.B., 1987, "Time Series Regression With a Unit Root," Econometrica 55, 277-301.

Phillips, P.C.B. and P. Perron, 1986, "Testing for a Unit Root in the Time Series Regression," CFDP n. 785, Yale University.

Phillips, P.C.B. and S. Ouliaris, 1987, "Asymptotic Properties of Residual Based Tests for Cointegration," CFDP n. 847, Yale University.

Poterba, J. and J. Rotemberg, 1987, "Inflation and Taxation With Maximizing Governments," unpublished manuscript.

Trehan, B., and C. Walch, 1987, "Common Trends, The Government's Budget Constraint and Revenue Smoothing," unpublished manuscript.

Appendix

The data are from the International Monetary Fund IFS tape:

(1) Monetary Base	line 14
(2) Government Revenues*	line 81
(3) Government Expenditure*	line 82
(4) Nominal GNP	line 99A
(5) Real GNP	line 99A.P
(6) Nominal GDP	line 99B
(7) Real GDP	line 99B.P
(8) Price Level	line (4)/(5) or (6)/(7)

* France data, not available from the IFS, are from the OECD National Accounts, Income and Outlay Transactions of General Government.

Table 1

INFLATION RATE

	1950-70	71-78	79-86	50-86
Belgium	0.03	0.08	0.05	0.05
Denmark	0.05	0.10	0.08	0.07
France	0.04	0.09	0.10	0.07
Germany	0.03	0.06	0.03	0.04
Greece	0.04	0.13	0.20	0.10
Ireland	0.04	0.14	0.11	0.08
Italy	0.04	0.14	0.17	0.10
Netherlands	0.04	0.09	0.04	0.05
Spain	0.08	0.15	0.14	0.12
United Kingdom	0.04	0.13	0.10	0.07
Mean	0.04	0.11	0.10	0.07
Standard Deviation	0.014	0.032	0.054	0.026

Table 2

EXPENDITURE/OUTPUT RATIO

	1950-70	71-78	79-86	1950-86
Belgium	0.24	0.29	0.41	0.30
Denmark	0.19	0.33	0.41	0.27
France	0.37	0.41	0.49	0.41
Germany	0.15	0.27	0.31	0.21
Greece	0.18	0.23	0.31	0.22
Ireland	0.29	0.40	0.50	0.36
Italy	0.15	0.26	0.37	0.23
Netherlands	0.25	0.30	0.39	0.29
Spain	0.12	0.21	0.29	0.19
United Kingdom	0.28	0.35	0.40	0.32
Mean	0.22	0.31	0.39	0.28
Standard Deviation	0.076	0.069	0.074	0.068

Table 3

UNIT ROOT TESTS: TAXES
Phillips-Perron Z_α Z_μ and Z_τ

		T			τ	
	Z_α	Z_μ	Z_τ	Z_α	Z_μ	Z_τ
Belgium	0.22 (<90)	-5.03 (>95)	-6.14 (<90)	-0.35 (<90)	-0.93 (<90)	-10.83 (<90)
Denmark	0.19 (<90)	-0.61 (<90)	-4.08 (<90)	0.18 (<90)	-0.81 (<90)	-8.86 (<90)
France	0.26 (<90)	-0.63 (<90)	2.18 (<90)	-0.34 (<90)	0.19 (<90)	-11.79 (<90)
Germany	0.39 (<90)	-0.82 (<90)	-8.21 (<90)	-0.43 (<90)	-0.99 (<90)	-7.19 (<90)
Greece	0.40 (<90)	-0.58 (<90)	-21.96 (>95)	-0.31 (<90)	-4.96 (<90)	-23.05 (>95)
Ireland	0.24 (<90)	0.27 (<90)	-6.13 (<90)	-0.44 (<90)	-0.34 (<90)	-15.31 (<90)
Italy	0.21 (<90)	-0.34 (<90)	-16.62 (<90)	-0.39 (<90)	0.42 (<90)	-4.49 (<90)
Netherlands	0.15 (<90)	-0.33 (<90)	-5.17 (<90)	0.05 (<90)	0.21 (<90)	-5.29 (<90)
Spain	0.22 (<90)	-0.85 (<90)	-3.18 (<90)	-0.44 (<90)	-0.75 (<90)	-10.37 (<90)
U.K.	0.09 (<90)	-3.68 (<90)	-33.37 (>99)	0.01 (<90)	-31.38 (>99)	-31.85 (>99)

Notes: Z_α tests H_0: $y_t = y_{t-1} + \epsilon_t$ against H_1: $y_t = \rho y_{t-1} + \epsilon_t$; $|\rho|<1$

Z_μ tests H_0: $y_t = y_{t-1} + \epsilon_t$ against H_1: $y_t = \alpha + \rho y_{t-1} + \epsilon_t$; $|\rho|<1$

Z_τ tests H_0: $y_t = \alpha + y_{t-1} + \epsilon_t$ against H_1: $y_t = \alpha + (t-T/2) + \rho y_{t-1} + \epsilon_t$; $|\rho|<1$

The number in parenthesis indicates the confidence level with which, H_0: Unit Root, is rejected.

Table 4

UNIT ROOT TESTS: SEIGNIORAGE
Phillips-Perron Z_a Z_μ and Z_τ

	S			π		
	Z_a	Z_μ	Z_τ	Z_a	Z_μ	Z_τ
Belgium	-0.76 (<90)	-4.89 (<90)	-7.57 (<90)	0.04 (<90)	-5.03 (<90)	-6.14 (<90)
Denmark	-0.22 (<90)	-16.01 (>95)	-26.77 (>97.5)	-14.23 (>99)	-14.62 (>95)	-24.14 (>95)
France	-0.94 (<90)	-11.26 (<90)	-20.31 (>90)	-0.33 (<90)	-9.57 (<90)	-17.62 (<90)
Germany	-1.68 (<90)	-18.93 (>97.5)	-26.11 (>97.5)	-9.99 (>95)	-12.24 (>90)	-22.95 (>95)
Greece	-1.12 (<90)	-7.30 (<90)	-15.44 (<90)	-0.39 (<90)	-2.73 (<90)	-17.60 (<90)
Ireland	-7.17 (>90)	-33.04 (>99)	-35.72 (>99)	-5.63 (>90)	-29.41 (>99	-35.06 (>99)
Italy	-3.92 (<90)	-29.89 (>99)	-33.16 (>99)	-0.25 (<90)	-17.61 (>97.5)	-29.95 (>99)
Netherlands	-2.25 (<90)	-41.81 (<99)	-43.09 (>99)	-36.77 (<90)	-40.53 (>99)	-43.44 (>99)
Spain	-0.53 (<90)	-6.03 (<90)	-8.17 (<90)	0.29 (<90)	-3.54 (<90)	-8.34 (<90)
U.K.	-0.68 (<90)	-10.83 (<90)	-16.44 (<90)	0.12 (<90)	-10.67 (<90)	-12.95 (<90)

Table 5

UNIT ROOT TESTS: EXPENDITURE
Phillips-Perron Z_a Z_μ and Z_τ

	G			g		
	Z_a	Z_μ	Z_τ	Z_a	Z_μ	Z_τ
Belgium	0.23	-0.46	-7.81	-0.47	-0.12	-5.90
	(<90)	(<90)	(<90)	(<90)	(<90)	(<90)
Denmark	0.20	-0.55	-3.12	0.20	-0.62	11.52
	(<90)	(<90)	(<90)	(<90)	(<90)	(<90)
France	0.26	-0.36	-3.54	-0.37	0.78	-7.64
	(<90)	(<90)	(<90)	(<90)	(<90)	(<90)
Germany	0.39	-0.79	-11.56	-0.45	-1.15	-7.89
	(<90)	(<90)	(<90)	(<90)	(<90)	(<90)
Greece	0.45	-0.48	-28.70	-0.54	-0.48	-15.50
	(<90)	(<90)	(>97.5)	(<90)	(<90)	(<90)
Ireland	0.25	-0.13	-5.61	-0.71	-1.18	-10.42
	(<90)	(<90)	(<90)	(<90)	(<90)	(<90)
Italy	0.22	0.01	-12.84	-0.48	0.59	-5.33
	(<90)	(<90)	(<90)	(<90)	(<90)	(<90)
Netherlands	0.17	-0.24	-11.74	-0.08	0.45	-7.98
	(<90)	(<90)	(<90)	(<90)	(<90)	(<90)
Spain	0.25	-0.79	-4.32	-0.60	-0.41	-11.67
	(<90)	(<90)	(<90)	(<90)	(<90)	(<90)
U.K.	0.12	-0.12	-11.65	0.07	-0.69	-11.46
	(<90)	(<90)	(<90)	(<90)	(<90)	(<90)

Table 6A

COINTEGRATION TEST: TOTAL SEIGNIORAGE AND TOTAL TAXES

AUGMENTED DICKEY-FULLER

	C	T	R^2	ADF
Belgium	-2.53 (3.62)	1.32 (5.24)	0.49	2.44
Denmark	-1.27 (4.76)	0.68 (4.68)	0.38	1.58
France	-2.42 (4.88)	1.20 (6.88)	0.59	5.06
Germany	-4.39 (3.34)	2.07 (3.55)	0.27	5.09
Greece	-4.70 (8.87)	2.47 (10.60)	0.78	4.25
Ireland	-5.86 (2.82)	2.29 (3.51)	0.23	4.05
Italy	-10.27 (2.52)	2.85 (3.30)	0.25	3.59
Netherlands	-3.23 (2.30)	1.66 (2.10)	0.09	2.34
Spain	-0.96 (2.38)	0.94 (7.70)	0.74	2.68
U.K.	-1.94 (3.43)	1.05 (3.21)	0.21	1.95

Notes: The ADF tests the hypothesis of no-cointegration. High values of ADF reject the hypothesis. Critical values for one explanatory variable are (Phillips-Ouliaris (1987)):

Confidence level:	0.01	0.025	0.05	0.075	0.10
Critical value:	3.94	3.49	3.34	3.16	3.05

Table 6B

COINTEGRATION TEST: TOTAL SEIGNIORAGE AND TOTAL EXPENDITURE

AUGMENTED DICKEY-FULLER

	C	G	R^2	ADF
Belgium	-1.91 (2.75)	1.06 (4.39)	0.40	2.42
Denmark	-1.13 (4.67)	0.61 (4.59)	0.37	1.41
France	-2.35 (4.77)	1.17 (6.78)	0.58	4.72
Germany	-4.17 (3.07)	1.95 (3.27)	0.23	5.10
Greece	-4.16 (8.58)	2.17 (10.48)	0.77	4.07
Ireland	-5.59 (2.76)	2.13 (3.47)	0.23	4.01
Italy	-8.09 (2.38)	2.35 (3.31)	0.25	3.80
Netherlands	-2.79 (2.20)	1.41 (1.98)	0.08	2.26
Spain	-0.80 (2.11)	0.89 (7.74)	0.74	2.63
U.K.	-2.21 (4.92)	1.20 (4.65)	0.37	2.13

Table 7A

COINTEGRATION TEST: INFLATION RATE AND TAX RATE

AUGMENTED DICKEY-FULLER

	C	τ	R^2	ADF
Belgium	0.53 (1.10)	3.16 (4.09)	0.37	2.67
Denmark	-0.39 (2.32)	1.46 (5.27)	0.44	2.65
France	0.55 (1.40)	4.45 (4.69)	0.40	3.96
Germany	-0.25 (0.27)	2.02 (1.59)	0.04	7.09
Greece	2.70 (3.19)	5.42 (4.68)	0.39	2.88
Ireland	1.48 (1.41)	5.17 (2.82)	0.16	4.09
Italy	1.49 (0.89)	4.04 (1.74)	0.06	3.14
Netherlands	0.13 (0.07)	3.13 (0.92)	0.0	2.66
Spain	-0.29 (1.57)	0.89 (3.67)	0.37	2.40
U.K.	-0.85 (2.20)	0.84 (1.12)	0.01	1.56

Table 7B

COINTEGRATION TEST: INFLATION AND EXPENDITURE RATE

AUGMENTED DICKEY-FULLER

	C	g	R^2	ADF
Belgium	-0.49 (1.49)	1.73 (2.89)	0.21	2.60
Denmark	-0.53 (3.72)	1.20 (5.32)	0.45	2.15
France	0.16 (0.47)	3.62 (4.39)	0.36	3.69
Germany	-0.69 (0.73)	1.46 (1.37)	0.01	7.37
Greece	1.12 (2.34)	3.56 (4.98)	0.43	3.04
Ireland	0.50 (0.68)	4.21 (2.72)	0.15	4.05
Italy	0.52 (0.54)	3.08 (2.06)	0.10	3.61
Netherlands	-0.54 (0.42)	1.93 (0.85)	0.0	2.44
Spain	-0.38 (2.28)	0.79 (3.61)	0.36	2.30
U.K.	0.47 (1.65)	3.49 (6.16)	0.51	2.55

Table 8A

COINTEGRATION TEST: TOTAL TAXES AND TOTAL EXPENDITURE

AUGMENTED DICKEY-FULLER

	C	G	R^2	ADF
Belgium	0.27 (3.81)	0.88 (35.34)	0.98	2.07
Denmark	0.19 (7.71)	0.90 (65.35)	0.99	3.00
France	0.05 (1.55)	0.98 (87.20)	0.99	1.87
Germany	-0.01 (0.31)	1.00 (60.59)	0.99	3.41
Greece	0.22 (7.77)	0.88 (79.92)	0.99	1.62
Ireland	0.11 (2.29)	0.94 (65.71)	0.99	3.38
Italy	0.80 (9.96)	0.82 (48.88)	0.99	1.78
Netherlands	0.19 (7.10)	0.89 (60.68)	0.99	0.21
Spain	0.18 (3.14)	0.94 (53.22)	0.99	0.78
U.K.	0.36 (3.01)	0.79 (11.56)	0.79	2.86

Table 8B

COINTEGRATION TEST: TAX RATE AND EXPENDITURE RATE

AUGMENTED DICKEY-FULLER

	C	g	R^2	ADF
Belgium	-0.26 (12.11)	0.66 (17.00)	0.91	2.72
Denmark	-0.10 (6.60)	0.81 (32.34)	0.97	3.01
France	-0.09 (5.33)	0.81 (19.20)	0.92	2.43
Germany	-0.04 (1.52)	0.97 (28.79)	0.96	3.42
Greece	-0.32 (14.96)	0.61 (18.81)	0.92	3.86
Ireland	-0.19 (11.79)	0.82 (24.30)	0.94	3.46
Italy	-0.32 (13.59)	0.63 (17.05)	0.91	1.38
Netherlands	-0.20 (9.73)	0.64 (16.93)	0.89	3.43
Spain	-0.10 (4.19)	0.89 (28.68)	0.98	0.86
U.K.	-0.28 (3.35)	0.44 (2.63)	0.14	3.10

Table 9

MONETARY BASE - GDP RATIO

	1950	1958	1968	1978	1986
Belgium	26.7	23.1	17.6	11.8	8.1
Denmark	11.6	10.7	8.4	3.9	4.7
France	16.9	15.1	13.6	7.2	6.1
Germany	11.8	11.7	10.1	11.2	9.4
Greece	8.8*	11.6	18.2	18.4	18.2
Ireland	15.9	14.4	16.8	15.3	10.2
Italy		16.5	16.5	21.8	15.4
Netherlands	17.3	15.1	10.3	6.6	7.6
Spain	14.5**	13.3	12.3	12.1	19.8
U.K.	13.5	10.9	9.4	6.7	4.2

* This number corresponds to Greece 1953

** This number corresponds to Spain 1952

Table 10

COINTEGRATION TEST: EXCHANGE RATE CONSTRAINT

AUGMENTED DICKEY-FULLER

	C	τ	τ^*	R^2	ADF
Belgium	0.85 (1.96)	2.10 (2.78)	0.67 (3.05)	0.52	2.85
Denmark	0.12 (0.60)	0.88 (3.11)	0.56 (3.62)	0.59	2.61
France	0.80 (2.19)	3.37 (3.57)	0.46 (2.78)	0.50	3.65
Germany	-5.65 (2.82)	-7.81 (2.24)	1.86 (3.00)	0.24	5.27
Greece	3.05 (3.57)	4.78 (3.99)	0.54 (1.60)	0.42	3.14
Ireland	2.68 (2.66)	3.43 (1.99)	1.61 (3.21)	0.33	3.97
Italy	2.74 (1.29)	3.84 (1.65)	0.94 (0.96)	0.06	3.54
Netherlands	0.94 (0.51)	0.14 (0.03)	1.63 (2.13)	0.0	2.63
Spain	-0.68 (2.98)	1.23 (4.80)	-0.46 (2.47)	0.50	1.73
U.K.	-1.13 (4.09)	-0.28 (0.50)	0.31 (6.01)	0.51	3.63

Critical values for two explanatory variables (Phillips-Ouliaris, 1987):

Confidence level:	0.01	0.025	0.05	0.075	0.10
Critical value:	4.35	4.01	3.77	3.59	3.47

Table 11

SOLVENCY CONSTRAINT: DEFICIT INCLUSIVE OF INTEREST PAYMENT

	Z_{α}	Z_{μ}
Belgium	0.83 (<90)	-0.50 (<90)
Denmark	-6.62 (<90)	-6.67 (<90)
France	0.64 (<90)	-0.61 (<90)
Germany	-8.47 (>95)	-9.78 (<90)
Greece	1.34 (<90)	-1.46 (<90)
Ireland	1.03 (<90)	-0.47 (90)
Italy	0.56 (<90)	-2.20 (<90)
Netherlands	-1.12 (<90)	-2.16 (<90)
Spain	-2.34 (<90)	0.36 (<90)
U.K.	-22.33 (>99)	-22.25 (>99)

Endnotes

1 The title of this section was inspired by the title of Mundell (1973).

2 Even if not done here, it is possible to derive these type of cost function from more fully specified general equilibrium models. See Grilli (1988).

3 See Trehan and Walch (1987) for a formal derivation.

4 Different measures of seigniorage can be found in the literature. The most common are the inflation rate multiplied by real cash balances, the rate of growth of monetary base multiplied by real cash balances, and the nominal interest rate multiplied by real cash balances. Drazen (1985), provides a general measure of seigniorage which produces most of the popular measures as special cases.

5 Equations are not exactly true since, in general, $Cov(\tau_t, y_t)$ and $Cov(\pi_t, Y_t)$ are not zero.

6 See Giavazzi (1987).