Working Paper

INTERNATIONAL MONETARY FUND

IMF WORKING PAPER

WP/89/40

INTERNATIONAL MONETARY FUND

European and Research Departments

"Optimal Taxation Policies in the EMS:
A Two-Country Model of Public Finance"

by Carlos A. Végh and Pablo E. Guidotti

Approved for Distribution by Michael Deppler and Donald J. Mathieson

May 8, 1989

Abstract

This paper analyzes, in a public finance context, how the optimal use of the inflation and the consumption tax is affected by incorporating into the model constraints on policy decisions that are likely to develop in the context of the EMS by 1992. Two main questions are addressed: first, how the constraint of having to share a common inflation tax, in order to preserve fixed-exchange rates, influences the optimal policy decisions concerning the inflation tax; secondly, how the harmonization of consumption taxes affects the spread between national inflation rates, and hence the probability of having to resort to realignments.

JEL Classification Nos.:
430, 320

1/ The authors wish to acknowledge helpful comments from Joshua Aizenman, Klaus-Walter Riechel, and participants at a seminar in the Research Department. They retain responsibility, however, for any remaining errors.

Table of Contents

Summary

This paper investigates how the type of constraints likely to develop in the context of the European Monetary System (EMS) by 1992 impacts upon the optimal taxation structure that would prevail in the absence of those constraints. The analysis is carried out in a public finance context where seigniorage is an important source of revenue because high government spending coupled with inefficient tax administration systems makes relying on conventional consumption or income taxes relatively more costly.

Two main questions are addressed. First, the paper explores how the constraint of having to share a common inflation tax in order to preserve fixed exchange rates in the context of perfect capital mobility influences the optimal policy decisions concerning the inflation tax. The analysis suggests that the common inflation tax is closer to that of the country that originally had the highest inflation. The inefficiency of the tax administration system plays a more crucial role than does spending by the different levels of government. Depending on the initial tax structure of each country, the original consumption taxes may either converge or diverge. The effects on the revenues from money creation as a fraction of total revenues are also analyzed.

Second, the paper discusses how the harmonization of consumption taxes affects the spread between national inflation rates and hence the probability of having to resort to realignments. The analysis suggests that national nominal interest rates will be subjected to important changes as a result of the large changes in revenues produced by the equalization of the consumption tax rates owing to the relative unimportance of seigniorage as a source of revenue.

I. Introduction

The topic of convergence of national policies within the EMS has received considerable attention over the years. 1/ The comprehensive financial integration within the EMS scheduled for 1992 has rendered the topic even more relevant in the minds of both researchers and policy-makers. In particular, as regards the implications of the EMS for national inflation rates, the discussion has focused on whether the system would impart an inflationary or a disinflationary bias. While some have argued that low-inflation countries would suffer from inflationary pressures from high-inflation countries, others have suggested that the opposite would take place. As pointed out by Guitián (1988), the evidence has been inconclusive so that, on a factual basis, it is difficult to argue that the EMS has imparted, so far, either an inflationary or a disinflationary bias.

The issue of national inflation rates is in turn related to the fiscal policies of the individual countries insofar as revenues from money creation may constitute an important fraction of government revenues. 2/ For some countries within the EEC (for instance, Portugal and Greece), seigniorage accounts for around 10 percent of total revenues. Furthermore, as suggested by Giavazzi and Giovannini (1988) "Differences in fiscal structures thus justify differences in the "optimal" revenue from seigniorage. In all likelihood the "optimal" inflation rate is not the same across Europe..." (p. 303).

In view of the links among the convergence of national inflation rates, the revenues from money creation, and fiscal policies, it seems important to attempt to provide a framework of analysis where the essential features of these relationships can be isolated and analyzed in detail. Such a conceptual apparatus should in turn prove useful to think about policy matters where these issues may be involved but, because of the presence of other macroeconomic problems (for instance, output effects of monetary policy), it may prove difficult to assess their importance and implications.

To analyze these public finance issues, this paper extends to a two-country world the framework based on Végh (1988) where the relative importance of seigniorage as a source of revenue results from high government spending coupled with inefficient tax administration systems that make it relatively more costly to rely on conventional consumption or

---

1/ See, for instance, Guitián (1988) and Russo and Tullio (1988) for a thorough review.

2/ See Giavazzi and Giovannini (1988).

income taxes. 1/ It has long been recognized that a key feature that distinguishes the inflation tax from other, "conventional," taxes is that the former is almost costless to collect compared to the latter. 2/ Aizenman (1987) incorporates this characteristic of the inflation tax into an optimal taxation problem by assuming that a consumption tax, which is the other tax available to the government besides the inflation tax, carries collection costs and concludes that the optimal inflation tax is positive. 3/ If transaction costs are introduced as in Kimbrough (1986), however, Végh (1988) shows that the optimal inflation tax does not depend on the level of government spending but only on the collection costs parameter. This is due to the assumption of constant marginal collection costs; if marginal costs are increasing (i.e., total collection costs are a convex function of the revenues from the consumption tax), Végh (1988) shows that the optimal inflation tax is an increasing function of government spending. Furthermore, the more inefficient the tax administration system, the larger the increase in the optimal inflation tax for a given increase in government spending.

Within the public-finance framework just described, this paper investigates how the type of constraints imposed by a system like the EMS impacts upon the optimal taxation structure that would prevail in the absence of those constraints. Specifically, the first issue to be addressed is the following. As mentioned earlier, if collection costs and/or levels of government spending differ among individual countries, governments would optimally choose, under flexible exchange rates, different taxation structures and, in particular, a different nominal

---

1/ Phelps (1973) pioneered the study of the optimal inflation tax within a public finance context. He reaches the conclusion that it is optimal to resort to a positive inflation tax. Kimbrough (1986) challenges Phelps' result and concludes that, if money is modeled as reducing transaction costs (unlike including money in the utility function as in Phelps (1973)), it is not optimal to resort to inflationary finance. Guidotti and Végh (1988) argue that Kimbrough's result depends critically on a particular assumption about the transactions technology and that Phelp's (1973) result may still hold.

2/ For the purposes of this paper, the inflation tax is defined as the nominal interest rate. This definition originates in Phelps (1973) and has been stressed by Auernheimer (1974). It is based on the argument that, by issuing nominal debt which bears no interest (namely, money), the government avoids paying the prevailing nominal interest rate. The consumer's opportunity cost of holding money, thus accrues to the government. Hence, in what follows, the terms "inflation tax" and "nominal interest rate" will be used interchangeably.

3/ Végh (1989) shows that, in the context of a small open economy, the presence of currency substitution also renders the optimal inflation tax positive. This is because a positive domestic nominal interest rate mitigates the distortion introduced into the economy by a positive foreign nominal interest rate.

interest rate. 1/ If an EMS-type of arrangement is established in which exchange rates are supposed to remain fixed over the long haul, this imposes the constraint of having a common nominal interest rate. Two important questions arise: first, will the resulting common nominal interest rate be closer to that of the high-inflation country or to that of the low-inflation country? (in other words, will there be an inflationary or a disinflationary bias?). Second, how will the levels and differences in government spending and the relative efficiency of both tax administration systems affect whether there is an inflationary or a disinflationary bias?

The second issue to be dealt with concerns the equalization across countries of consumption taxes. Given that the EMS contemplates, and most likely still will after 1992, the possibility of periodic realignments, it follows that national inflation rates may differ across countries for a given period of time. This raises the question, which is also related to current discussions in the EMS, as to how the differential between national inflation rates would be affected by equating, say, consumption taxes across countries. Put differently, would such tax harmonization policies make it easier or more difficult to sustain fixed parities with only occasional realignments?

It is worth stressing at this point that the model does not incorporate explicitly whatever benefits may result from establishing a fixed-exchange-rate regime or equalizing consumption taxes. The rationale for not doing so is two-fold. First, the desire to maintain analytical tractability for the model is already quite complex, from an analytical point of view, without these additional features. Secondly, there is certainly not a consensus of precisely what are the benefits of fixed over flexible exchange rates or what are the advantages of tax harmonization so that there is not an obvious way of incorporating these potential benefits into the model. Therefore, this model should be viewed as isolating and analyzing the costs associated with the type of constraints that the EMS may impose upon its members while abstracting from the potential benefits. (Clearly, since we will be comparing solutions to an unconstrained optimization problem to the solutions to a constrained optimization problem, the latter can, at most, be as good, in terms of welfare, as the former.) However, insofar as the simulation of the model suggests that the costs imposed by the constraints are negligible, as will be the case when a common nominal interest rate is required, there is certainly the presumption that the benefits of a system of fixed-exchange-rates, in terms, say, of more stable real exchange rates, would outweigh these costs. 2/

1/ Since the model abstracts from capital accumulation, the real interest rate equals the common rate of time preference. Setting the nominal interest rate is thus equivalent to choosing the inflation rate.

2/ See Giavazzi and Giovannini (1988) for a discussion of the benefits that the members of the EMS place on a system of fixed exchange rates.

The paper proceeds as follows. Section II reviews the determination and dependence of the optimal inflation tax on government spending and the efficiency of the tax administration system in each individual country under flexible exchange rates. This provides the benchmark case against which the more complex, analytically speaking, optimality conditions of the two-country model with fixed-exchange rates can be compared and thus understood. Section III introduces the two-country model with fixed-exchange rates and analyzes the consequences of imposing the constraint that the nominal interest rate be equalized across the two countries. It is shown that the common inflation tax is closer to that of the originally high-inflation country. The inefficiency of the tax administration system is shown to play the crucial role as opposed to that played by the different levels of government spending. It is shown that the original consumption taxes may either converge or diverge depending on the initial tax structure of each country. The effects on the revenues from money creation as a fraction of total revenues are also analyzed. Section IV deals with the case where equality among consumption taxes is imposed. The analysis suggests that national nominal interest rates will be subjected to important changes as a result of the large changes in revenues produced by the equalization of the consumption tax rates due to the relative unimportance of seigniorage as a source of revenue. Section V contains concluding remarks.

II. The Two-Country Model under Flexible Exchange Rates

This section considers the optimal taxation policies for each individual country in a two-country model under flexible rates. While the results of this section can be found in the existing literature, it is important to derive them in such a way that they provide the key conceptual ingredients to understand the new results that obtain in the two-country model with fixed-exchange rates in Section III and the two-country model where the constraint of equal consumption taxes is imposed in Section IV. 1/ Since the structure of model can be found elsewhere, the presentation, while self-contained, will be as brief as possible. 2/ Both countries will be assumed to be identical; therefore only the domestic country will be introduced. The variables pertaining to the foreign country will be denoted by an asterisk.

1/ As long as we are dealing with stationary equilibria (i.e., the system is always at the steady state), the results obtained for a closed economy, a small open economy under flexible exchange rates, or large economies operating under flexible rates are the same.

2/ The consumer's problem is the one put forward by Kimbrough (1986), which can also be found in Guidotti and Végh (1988) and Végh (1989). The introduction of increasing marginal collection costs for the consumption tax into the government's optimal taxation problem follows Végh (1989).

For simplicity, it will be assumed that this is a one-good world. This good is produced under a constant-returns-to-scale technology given by

$$y_t = n_t \qquad t=0,1,.., \tag{1}$$

where y denotes units of the good, n stands for labor input, and units have been defined in such a way that producing one unit of the good requires one unit of labor. Labor is taken to be the numeraire.

The domestic consumer holds two assets: domestic money and an internationally traded bond whose rate of return is r. 1/ The consumer holds money in order to reduce transactions costs or shopping time. Specifically, the time that the consumer devotes to transacting is given by

$$s_t = v(X)_t)c_t(1+\theta_t), \qquad v' \leq 0,\ v''>0,\ v'(X^s_t)= 0 \text{ for } 0 \leq X \leq X^s_t \tag{2}$$

where $X_t = m_t/[c(1+\theta_t)]$. 2/ We will refer to X as "relative money balances." Equation (2) indicates that additional relative money balances bring about positive but diminishing reductions in shopping time for a given expenditure on consumption. There is a level of relative money balances, X^s, where the consumer is satiated in the sense that no further reductions in shopping time are feasible. It will be assumed that when that level of relative money balances is achieved, transaction costs are zero. 3/ Assuming that the consumer is endowed with one unit of time in every period, the time constraint that he or she faces is

$$n_t + s_t + h_t = 1, \tag{3}$$

where h denotes leisure. The consumer's optimization problem can now be formally stated as

---

1/ The foreign consumer holds only foreign money and the traded bond; namely, there is no currency substitution.

2/ It should be clear that, given the non-negativity constraint on the nominal interest rate, the consumer would never choose $X>X^s$ so that the constraint on the range of X does not imply any loss of generality.

3/ As pointed out by Guidotti and Végh (1988), this assumption is critical in obtaining the result that the optimal inflation tax is zero in the absence of collection costs. If transactions costs are not zero when $v'(X^s)=0$, the optimal inflation tax is positive, as will become clear below.

$$\underset{\{c_t,h_t,m_t\}_{t=0}^{\infty}}{\text{Maximize}} \quad \sum_{t=0}^{\infty} \beta^t \ U(c_t,h_t)$$

subject to

$$\sum_{t=0}^{\infty} d^t(1-h_t) = \sum_{t=0}^{\infty} d^t[c_t(1+\theta_t) + s_t + I_t m_t] \ , \tag{4}$$

where

$$d^t \equiv \prod_{j=1}^{t}[1/(1+r_{j-1})]$$

the interest rate discount factor; $d^0 \equiv 1$, β is the constant utility discount factor; the instantaneously utility function $U(c,h)$ is twice-continuously differentiable, with positive and diminishing marginal utilities; c stands for consumption of the good; s is given by (2); and $I_t \equiv [i_t/(1+i_t)]$, where i is the nominal interest rate. The consumer can be viewed as following a two-stage optimization process because real money balances enter the maximization problem only through the budget constraint. In the first stage, then, the consumer chooses an optimal amount of real money balances which yields $v'(X_t)=I_t$ as the first order condition. This optimality condition says that the consumer equates the benefit in terms of reduced shopping time of holding an additional unit of money to its opportunity cost. Solving for X_t (namely, $X_t=X_t(I_t)$) and substituting it into (4) yields the following budget constraint:

$$\Sigma_{t=0}^{\infty} d^t(1-h_t) = \sum_{t=0}^{\infty} d^t(q_t c_t) \tag{5}$$

where

$$q_t = q_t(I_t,\theta_t) = (1+\theta_t)\{1+v[X_t(I_t)] + I_t X_t(I_t)\}. \tag{6}$$

Note that q can be thought of as the "effective" price of consumption, as compared to the market price, which equals $(1+\theta)$. For our purposes, however, it is best to think of (q-1) as the distortion introduced into the consumer's leisure/consumption choice as a result of the presence of distortionary taxation. Clearly, if both taxes were zero, (i.e., $I_t=\theta_t=0$), then there would be no distortion; namely, q would equal

unity. The consumer can now be viewed as maximizing over $\{c_t,h_t\}_{t=0}^{\infty}$ his or her utility functional subject to (5). In addition to (5), the other two first order conditions can be combined to yield

$$\frac{U_c(c_t,h_t)}{U_h(c_t,h_t)} = q_t \qquad t = 0,1,.. \tag{7}$$

whereby the consumer equates the marginal rate of substitution between consumption and leisure to its relative price. It can be shown that, given that government spending will be assumed to be constant over time, the optimal taxation structure will also be constant over time; namely $\theta_t=\theta$ and $I_t=I$ for all t. 1/ Given that the consumer balances his or her budget in every period and taken into account (7), it follows that $c=c(q)$ and $h=h(q)$ where $(\partial c/\partial q)<0$ and $(\partial h/\partial q)\gtrless 0$. Substituting these optimal choices into the utility function yields the indirect utility function $V(q)\equiv U[c(q),h(q)]$, where $(\partial V/\partial q)<0$.

The optimal taxation problem facing the domestic government is to maximize V(q) over $\{\theta,I\}$ or, which amount to the same thing since V(q) is decreasing in q, to minimize q subject to the constraint that its budget be balanced in every period. Formally, minimize q subject to:

$$g = [1-\phi(\theta c)]\theta c + IX(1+\theta)c \tag{8}$$

where $\phi(\theta c)$ represents the collection costs of an additional unit of revenue through the consumption tax and, for simplicity, will be assumed to take the linear form $\phi(\theta c)=k\theta c$, where k is a non-negative parameter. 2/ Taking this particular functional form into account, rewrite for

---

1/ If the primal approach to optimal taxation is used (Atkinson and Stiglitz (1972)), as in Végh (1987), it follows immediately that, if the exogenous variables are constant over time, the optimal social choices of (c,h,m) are constant over time. For this optimal social allocation to be the outcome of a competitive equilibrium, (I,θ) have to remain constant over time. The intuition is simply that constant expenditures across time are optimally financed from contemporaneous taxes because it is optimal to smooth tax distortions over time (see, for instance, Lucas and Stokey (1985)). Therefore, the economy is always in the steady state where $r=\delta^*=\delta$ and will adjust instantaneously to unanticipated changes in the exogenous parameters (Obstfeld and Stockman (1985)). Accordingly, in what follows the analysis will be conducted in the steady state and time subscripts will be dropped for notational simplicity.

2/ The key results that obtain with this particular specification extend to a general $\phi(\theta c)$, as shown in Végh (1988).

analytical convenience (8) as $g=c\Gamma(c,\phi,I)$ where $\Gamma(c,\phi,I)=(1-k\theta c)\theta+IX(1+\theta)$. In addition to (8), the first order conditions for this minimization problem can be shown to yield:

$$\frac{q_\theta}{q_I} = \frac{1 + v[X(I)] + IX(I)}{X(I)} = \frac{1 - 2k\theta c + IX(I)}{X(I) + I(\partial X/\partial I)} = \frac{\Gamma_\theta}{\Gamma_I} \qquad (9)$$

where $c=c[q(\theta,I)]$. It is optimal to equate the marginal rate of substitution between the two taxes along a utility-indifference curve to the marginal rate of transformation per unit of consumption along an iso-revenue curve. 1/ If the consumption tax carries no collection costs (i.e., $k=0$), it is simple to check (given that $v[X(0)]=0$) that $I=0$ is the solution to (9) so that all public spending is financed with the consumption tax; this is Kimbrough's (1986) result. 2/ When $k>0$, the case studied by Végh (1988), two aspects of the solution are worth noticing. First, $I=0$ is no longer a solution to (9). Second, the optimal I, $I°$, depends on the level of government spending because the presence of c in (9) implies that (9) does no longer implicitly define a reduced form for $I°$. In other words, equation (8) and thus g influence $I°$. In the general case where $k\geq 0$ equations (8) and (9) implicitly define $I°=I°(g,k)$ and $\theta°=\theta°(g,k)$ where $I(g>0,0)=0$, $I(g>0,k>0)>0$, $[\partial I°(g,k>0)/\partial g]>0$ and $[\partial I°(g>0,k)/\partial k]>0$. 3/ The foreign country faces an identical problem that determines the optimal taxes (I^*,θ^*). Given that the good produced in both countries is the same, the law of one price holds; namely $\Pi=\hat{e}+\Pi^*$, where Π and Π^* denote the domestic and foreign rates of inflation and $\hat{e}$ the rate of depreciation of the exchange rate (units of domestic currency per unit of foreign currency). Making use of the Fisher conditions, $i=\delta+\Pi$ and $i^*=\delta^*+\Pi^*$, it follows that $\hat{e}=i-i^*$ (recall that $\delta=\delta^*$).

1/ It should be pointed out that the slope of the iso-revenue curve is $[(c_q q_\theta\Gamma+c\Gamma_\theta)/(c_q q_I\Gamma+c\Gamma_I)]$ rather than (Γ_θ/Γ_I). But, an optimum, it can be verified that $(q_\theta/q_I) = [(c_q q_\theta\Gamma+c\Gamma_\theta)/(c_q q_I\Gamma+c\Gamma_I)]$ can be rewritten as (Γ_θ/Γ_I). This is because the negative effect on revenues of q that results from an increase in θ relative to that which results from an increase in I is proportional to the relative distortion introduced by both taxes.

2/ The main point of Guidotti and Végh (1988) also follows immediately from (9) by setting $k=0$. If $v[X(0)]>0$, it is easy to check that the solution to (9) is some positive I (recall that $\partial X/\partial I<0$). Money being an intermediate good, therefore, does not ensure, by itself, that it is optimal to follow the optimum quantity of money rule. For the purposes of this paper, however, the assumption $v[X(0)]=0$ will be maintained in order to concentrate on tax harmonization problems.

3/ Note that since I is increasing in i, it does not make any difference, qualitatively speaking, whether one works with I or i. Analytically, it proves more convenient to work with I.

It proves useful at this stage to put some quantitative content into the solution of the optimal taxation problem of both countries under flexible exchange rates in order to establish a numerical benchmark against which the results in the next two sections, which are derived from imposing the constraints $I=I^*$ and $\theta=\theta^*$, can be assessed.

For the purposes of obtaining numerical solutions, the utility function will be assumed to take the form $U(c,h)=\log(c)+\log(h)$. This implies that h is always equal to one-half. The function v(.) is assumed to be quadratic; namely $v(X)=X^2-aX+d$, where a=0.6 and d=0.09. 1/ Since this numerical exercise will roughly replicate actual inflation rates, we will identify the domestic country with Germany (the low-inflation country) and the foreign country with Italy (the high-inflation country) and take their average government spending during 1986-88 as the value for g and g^*. The value of k is chosen so as to generate the observed inflation rate. 2/ Thus, in the case of Germany, g = 0.225 (i.e., 45 percent of GDP) and k = 0.023 yield i = 0.6 percent; the revenues from money creation as a fraction of total revenues are 0.4 percent. For Italy, $g^* = 0.25$ (i.e., 50 percent of GDP) and a $k^* = 0.23$ generate $(i^*)^\circ = 6.7$ percent and revenues from money creation constitute 3.3 percent of total revenues. 3/ Given that the differences in government spending are rather small, the model explains the different inflation rates based on the relative efficiency of the tax structures. In this way, the model puts explicit analytical content into expressions such as "differences in fiscal structures" as used, for instance, by Giavazzi and Giovannini (1988), p. 303.

Having established the fact that, under flexible exchange rates, the optimal inflation tax in Germany and Italy would differ, the next section addresses the question of what would be the effects on the taxation structures of having to share a common inflation rate to sustain fixed parities (with no realignments possible).

1/ This specification of the model has been previously used by Végh (1987, 1988). It implies that the demand for relative money balances is linear in I.

2/ For simplicity, the real interest rate is assumed small enough so that the nominal interest rate can be identified with the inflation rate. Due to the highly abstract nature of the model, the specific numbers generated by the model throughout the paper should be viewed as illustrations rather than actual predictions.

3/ The actual figures (average for 1985-87) for revenues from money creation as a fraction of total revenues are 3.0 percent for Italy and 1.33 percent for Germany. (The source for the seigniorage figures is Gros (1988); government revenue figures are based on the EC Commission services.)

III. The Two-Country Model With a Common Inflation Tax

It is hard to disagree with the premise that if capital controls are completely eliminated by 1992 the sustainability of the EMS depends crucially on the convergence of monetary policies. If there is divergence between monetary policies, and hence inflation rates, any anticipated realignment would deplete the reserves of the devaluing country if it could not resort to capital controls to keep the necessary amount of reserves to defend the post-devaluation parity. Hence, unless capital controls were available in case of speculative attacks, as has been the case in the past, the EMS could not survive unless the EMS countries were willing to endure huge interest rate differentials when a realignment is expected. This point has been made, among others, by Wiplosz (1987) and Giavazzi and Giovannini (1988). This section addresses the convergence-of-monetary-policies scenario. It will be assumed that a fixed exchange rate is established between the two countries of the previous section and that the monetary authorities optimally choose a common inflation tax (i.e., they coordinate their monetary policies). We are mainly interested in finding out how this common optimal inflation tax will compare to those which are optimal under flexible rates; put differently, on whether the common inflation tax will be closer to the high or to the low-inflation-tax country.

The consumer in each of the two countries behaves exactly in the same way as before since nothing has changed as far as he or she is concerned. Recall that consumers of each country are assumed to be identical as regards their preferences and utility discount factor. The transaction-technology functions v(.) and $v^*(.)$ are also assumed to be the same (and will be denoted by v(.)); this enables us to isolate the effects of different levels of government spending and of different levels of efficiency in the tax collection system. Therefore, the consumer's problem remains unchanged and will not be repeated here. Suffice it to say that from the optimization problem of both consumers, V(q) and $V(q^*)$ result, where $q=(1+\theta)[1+v(X^w)]+I^wX^w)$ and $q=(1+\theta^*)[1+v(X^w)+I^wX^w]$. Variables that, in view of the constraints imposed on the problem, have to be the same in both countries will be denoted by the superscript "w". Thus, relative money balances will be the same in both countries since both consumers face a common interest rate, I^w, and the transactions technology is the same. The governments of the two countries, giving equal weight to their representative consumer, coordinate their monetary policies so as to choose a common inflation tax; formally, they face the following optimization problem: Maximize $V(q) + V(q^*)$ subject to:

$$g = c[(1-k\theta c)\theta + I^wX^w(1+\theta)] \tag{10}$$

$$g^* = c^*[(1-k^*\theta^*c^*)\theta^* + I^wX^w(1+\theta^*)] \tag{11}$$

In addition to (10) and (11), the optimality condition for this problem is:

$$\frac{V_q c \left[q_{I^w}\Gamma_\theta - q_\theta \Gamma_{I^w}\right]}{c_q q_\theta \Gamma + c\Gamma_\theta} = \frac{V_{q^*} c^* \left[q^*_{I^w}\Gamma^*_{\theta^*} - q_{\theta^*}\Gamma^*_{I^w}\right]}{c^*_{q^*} q^*_{\theta^*} + c^*\Gamma^*_{\theta^*}} \tag{12}$$

It is important to note that the terms in square brackets on both sides of equation (12) would be zero if the constraint that $I=I^*=I^w$ were not binding because optimality requires that these terms be zero in the flexible-exchange-rate case (recall equation (9)). For convenience, denote these terms by D and D^*, respectively. (The notation "D" stands for "deviation" because, as we have said, as long as D or D^* are different from zero, there is a deviation from the unconstrained optimal taxation structure.) To become familiar with the two-country model with fixed-exchange rates, consider the simplest case where $k=k^*=0$. Then we know from the previous section that the optimal inflation tax is zero independently of the level of g. This being so, we can guess that the solution in this case involves $I^w=0$ which implies that $D=D^*=0$. Then, it follows from (10) and (11) that $\theta=(g/c)$ and $\theta^*=(g^*/c^*)$. The joint solution coincides with the solution under flexible exchange rates. In other words, there is no welfare cost of having the same inflation tax since it would have been the same to begin with; formally this follows from the fact that $D=D^*=0$.

Suppose now that $k=0$ while $k^*>0$. From the previous section, we know that, under flexible exchange rates, $I°=0$ and $(I^*)°>0$. It can be readily checked that $I^w=0$ is not a solution because (9) does not hold; the left-hand-side is zero while the right-hand-side is negative. 1/ We can already assert, therefore, that $I^w>0$. Furthermore, at an optimum, $D>0$ and $D^*<0$. Figure 1 illustrates and clarifies the interpretation of the solution. (In all the figures that follow, a subscript "0" denotes the initial equilibrium and a subscript "1" refers to the final equilibrium.) The curves labeled g and g^* represent iso-revenues curves; namely, the locus of points (θ,I) and (θ^*,I^*) where revenues are constant. The curves labeled q_0, q_1, q_0^*, and q_1^* represent iso-distortion curves; that is, the locus of points along which the distortions $(q-1)$ and (q^*-1) remain constant. As we move downward (i.e., for a given I or I^*) the level of the distortion decreases and hence welfare increases. Consider the optimal taxation structure of the domestic country $(k=0)$. It is given by point E_0 where the iso-revenue curve g is tangent to the iso-distortion schedule q_0. The optimal taxation structure of the foreign country $(k^*>0)$ is given by point E_0^* where the schedule g^* is tangent to q_0^*. Because

1/ Note that at an optimum the denominators on both sides of equation (12) are positive. This follows from the first order conditions. It should also be clear that no corner solution can be involved in this case.

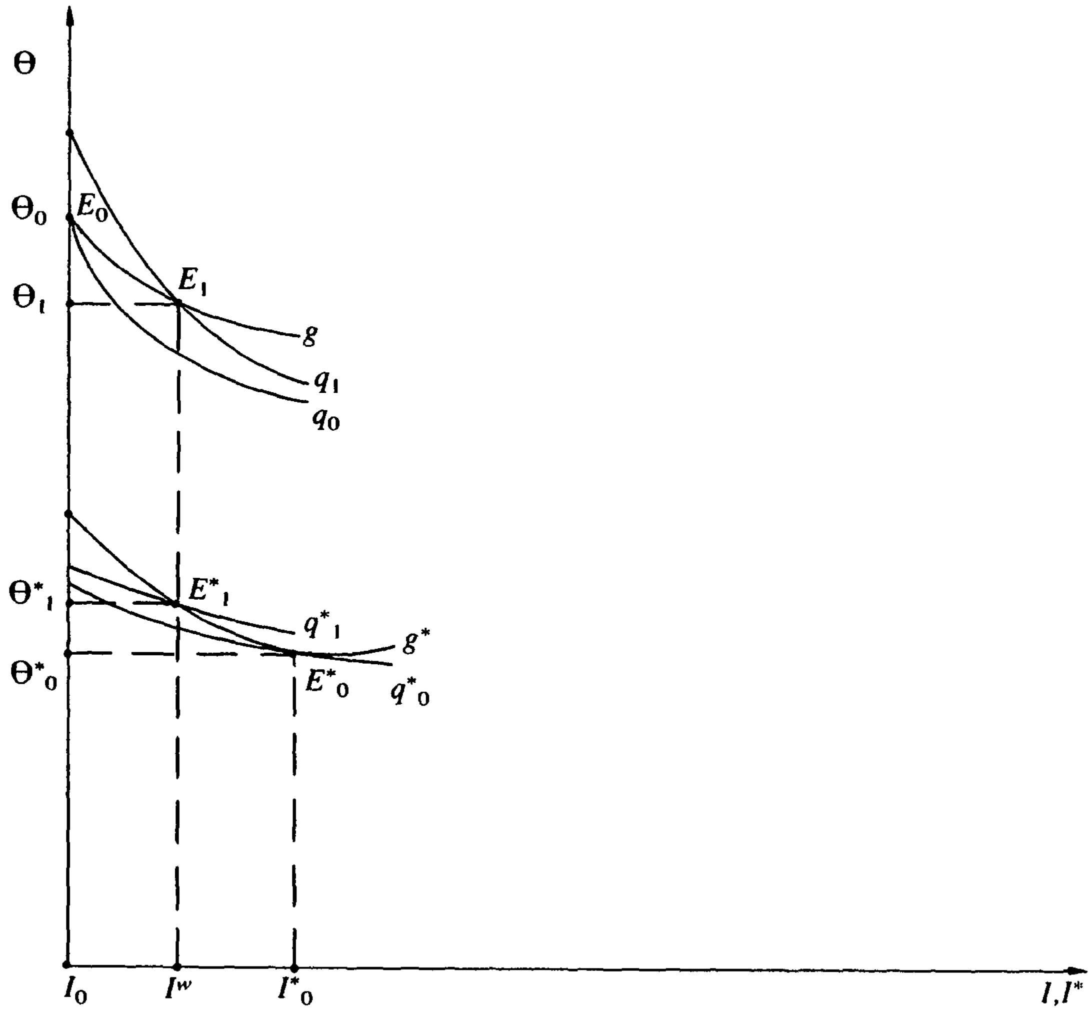
$k^{*}>0$, I_0^{*} is positive. Suppose now that the constraint that the nominal interest rate has to be the same in both countries is imposed. With the help of Figure 1 and taking into account equation (12) if follows that the optimal I^{W} lies somewhere between between I_0 and I_0^{*}. To see why, consider the initial situation in the domestic country. Since government spending remains unchanged, any movement towards the new optimum will imply moving along the iso-revenue curve g. This implies that, at the new optimum, the iso-distortion curve is steeper (in absolute value) than the iso-revenue curve as exemplified by point E_1 (where q_1 is steeper than g). Therefore, in equation (12) $D>0$ whence it follows that $D^{*}<0$ which implies that, as regards the foreign country, there is a leftward movement along the iso-revenue g^{*} because, to the right of E_0^{*}, D^{*} cannot be negative. Intuitively, the collection costs for the two-countries as a whole will be less than for the high-collection-cost country since it will involve, roughly speaking, some sort of average of the two individual collection-cost schedules. The same is true of the level of government spending. The costs, in terms of welfare, of having monetary policies converge are illustrated in Figure 1 by the fact that the new optima for both countries, E_1 and E_1^{*}, lie on higher iso-distortion curves than the initial, flexible exchange rates, optima at E_0 and E_0^{*}. 1/ In Figure 1, it is seen that the optimal consumption taxes tend to converge; namely, the difference between θ_0 and θ_0^{*} is less than that between θ_1 and θ_1^{*}. As it can be readily verified with the use of Figure 1, however, this need not always be the case. If the low-inflation country has the lowest consumption tax at the initial optimum, then the consumption taxes will diverge as a result of the imposition of a common nominal interest rate.

Proceeding with the numerical exercise initiated in the previous section, we now compute the common nominal interest rate if Germany and Italy were to agree on jointly setting monetary policy. Recall that for Germany the optimal inflation was 0.6 percent while for Italy it was 6.7 percent. Under the same parameter values, i^{w} turns out to be 4.2 percent. The ratio $(i^{w}/(i+i^{*})\equiv\alpha$ can be viewed as an indicator of whether the imposition of a common nominal interest rate induces an inflationary or disinflationary bias to the system. A value of α greater than 0.5 would indicate that there is an inflationary bias. In this particular case, α=0.572, which implies that the common inflation tax is 0.5 percent higher than the average of the initial inflation rates. As regards the welfare costs, they appear to be quite small under the present specification. Since leisure remains constant, the change in welfare depends exclusively on the change in consumption. Consumption in Germany

---

1/ Naturally, since potential benefits of having fixed exchange rates in the EMS (as discussed, for instance, by Giavazzi and Giovannini (1988)) have not been incorporated into the model, it is always welfare-reducing to fix exchange rates. These costs, however, will be present even if some benefits were taken into account. The way to think of the present model is as providing a conceptualization and an illustration of the costs that might be involved in unifying monetary policies. The model does not address the cost-benefit issue of fixing exchange rates.

Figure 1. Optimal Taxation Policies under Flexible and Fixed Exchange Rates



This page intentionally left blank

falls by 0.029 percent and in Italy by 0.016 percent. As one would have expected, since the common optimal nominal interest rate is closer to that of Italy, the fall in consumption in Italy is less than that in Germany but it is nonetheless negligible in both cases. Therefore, the numerical analysis suggests that the costs of unifying monetary policies are almost non-existent in this context. This is due to the fact that, since the revenues from the inflation tax are not important, the constraint that the inflation tax be equal in the two countries imposes only minor restrictions on the optimal fiscal structure. For the same reason, one can already anticipate that the constraint that the consumption taxes be equal (the issue to be addressed in the next section), will impose major restrictions on the optimal fiscal structures.

In order to interpret the inflationary bias induced by the unification of monetary policies, it is useful to think of the government's problem as follows. Using equation (10), solve for θ as a function of I, g, and k and replace it into $q(\theta,I)$ in the objective function $V(q)$. Analogously, solve for θ^* from (11) and replace it into $V(q^*)$. Thus, the problem faced by the government is transformed into an unconstrained optimization problem by replacing the constraints into the objective. The new objective is thus $V\{q(I;k,g)\}+V\{q(I^*;k^*,g^*)$ so that the only choice variables are I and I^*. Define the following loss function $L(I;g,k)\equiv V\{q(I^\circ;g,k)-V\{q(I;g,k)\}$. This loss function measures the loss, in terms of utility, of choosing an I other than the optimal one. Obviously, it reaches a minimum of zero when $I=I^\circ$. Under flexible exchange rates, the government can thus be viewed as minimizing $L(I;g,k)$ by choosing I; the optimum choice being I_0 as illustrated in Figure 2.

The vertical axis measures $L(I;g,k)$ and $L^*(I^*;g^*,k^*)$ and the horizontal axis I and I^*. Under flexible exchange rates, the optimum inflation taxes are I_0 and I_0^* where the loss, in terms of welfare, is reduced to zero. The shape of the loss functions should be intuitively clear; as we move either leftward or rightward from the optimal inflation tax, there is a welfare loss due to a sub-optimal choice of I which causes the distortion, and hence the welfare loss, to rise at an increasing rate. When the constraint of a common optimal inflation tax is imposed, the optimal I, I^W, takes place where the slope (in absolute value) of both loss functions is the same; namely, it is optimal, at the margin, to equate the welfare loss of the representative consumer in each country. If both countries had the same value of k, then the slope of the loss functions would be the same at the intersection of both curves and the common optimal inflation rate would be the average of the two initial optimal inflation taxes. Figure 3 illustrates how a change in the levels of government spending affect the optimal common inflation tax. Figure 3 assumes that g^* increases while g decreases. Since k and k^* remain unchanged, it follows from the analysis of the previous section that the optimal inflation tax in the domestic country under flexible exchange rates decreases (in Figure 3, $I_1 < I_0$) while the opposite is true in the foreign country (in Figure 3, $I_1^* > I_0^*$). The common optimal inflation tax increases from $I^W{}_0$ to $I^W{}_1$. It can be seen that the effect of the smaller g ($g_1<g_0$) is to shift the loss function of the domestic country to the left while the higher g^*

($g^*_1 > g_0$) shifts the loss function of the foreign country to the right. Given these shifts, it follows that, at the initial common optimal inflation tax, the slope of L^* is higher (in absolute value) than that of L and since as one moves to the right of I^w_0 the slope of L^* decreases (in absolute value) while that of L increases the new optimal common optimal inflation tax is greater than the initial one.

Tables 1 through 3 present numerical simulations of the model that illustrate the effects of different levels of government spending on the inflationary bias. The effect on the importance of seigniorage as a source of revenue is also investigated. The computations in Table 1 and 2 use the values of k obtained in Section II. We proceed to widen the differential between the levels of government spending from zero to 20 points of GDP (recall that GDP in both countries equals one-half) so that this exercise can be interpreted as suggesting how different levels of government spending in both countries would affect the common optimal inflation tax. Table 1 assumes that the level of government spending in the foreign country (the one with high collection costs) increases while that of the domestic country (the one with low collection costs) decreases. Table 2 undertakes the opposite exercise. An inspection of both tables reveal the following. First, when government spending is the same in the two countries, there is always an inflationary bias. In other words, the fact that one country has higher increasing marginal collection costs than the other is sufficient, given equal levels of government spending, to yield a common optimal nominal interest rate that is closer to that of the high-inflation country, as indicated by the value of α=0.548 in the first row of both tables. Second, given this initial value of α, if government spending increases in the high-collection-costs country while it decreases in the low-collection-costs country, the inflationary bias rises accordingly. As Table 1 shows, for instance, if the difference in government spending were 0.6 (equivalent to 12 percent of GDP), α=0.588. On the other hand, as suggested by Table 2, if the spread in the levels of government spending arises because of an increase in the low-collection-cost country and a decrease in the high-collection-cost country, the inflationary bias decreases and even turns to a disinflationary bias (namely, α<0.5) for a difference of 0.6 (12 percent of GDP) in which case α=0.492. The simulation thus suggests that, given the values of k derived in Section II that yielded inflation rates of roughly the same order of magnitude as those observed in Germany and Italy, an inflationary bias is more likely to be the outcome of unifying monetary policy since for the opposite to happen it should be the case that the low-collection-cost country have a considerable higher level of government spending that the high-collection-cost country.

Table 3 shows the effects of an increasing spread between levels of government spending in both countries on the inflationary bias <u>for a common value of k</u>. The purpose of this exercise is thus to isolate the effects of an increasing spread between levels of government spending on the inflationary bias. The figures of Table 3 clearly suggest that different levels of government spending hardly influence the inflationary bias. Even a substantial spread of 0.10 (20 percent of GDP), a rather

Figure 2. Determination of Optimal Inflation Tax using Loss Functions

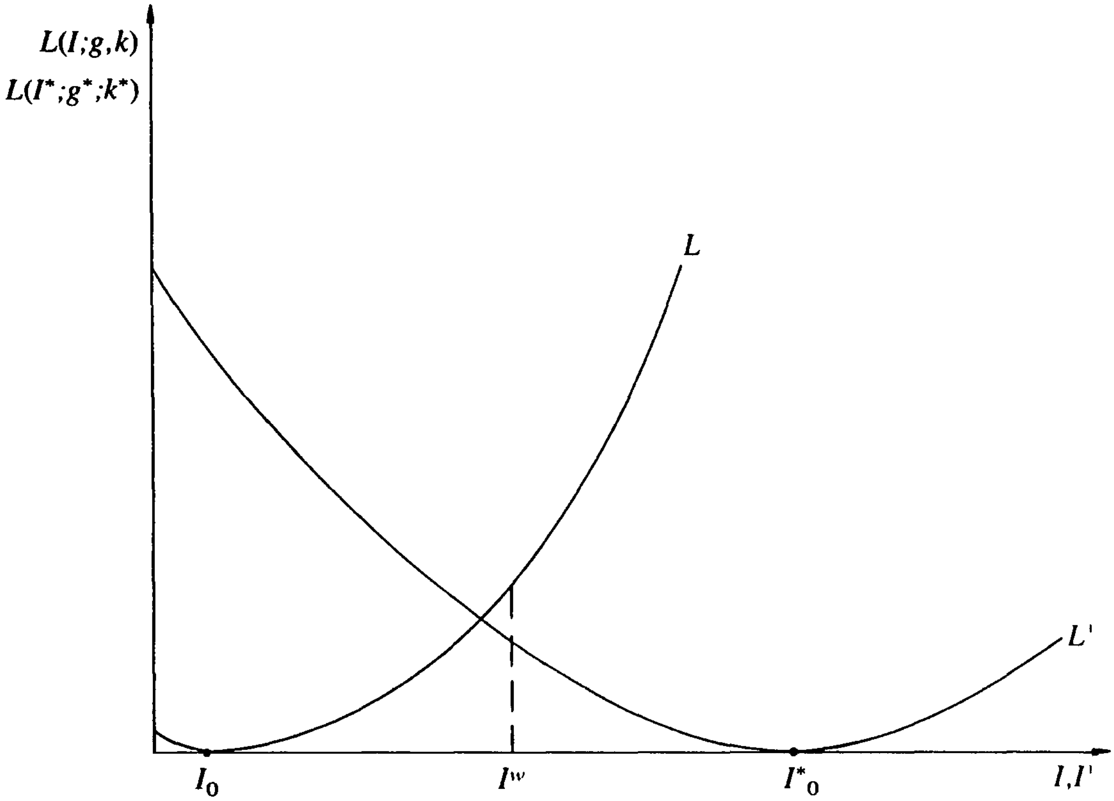


Figure 3. Effects of a Higher Difference in Levels of Public Spending on the Common Optimal Inflation Tax

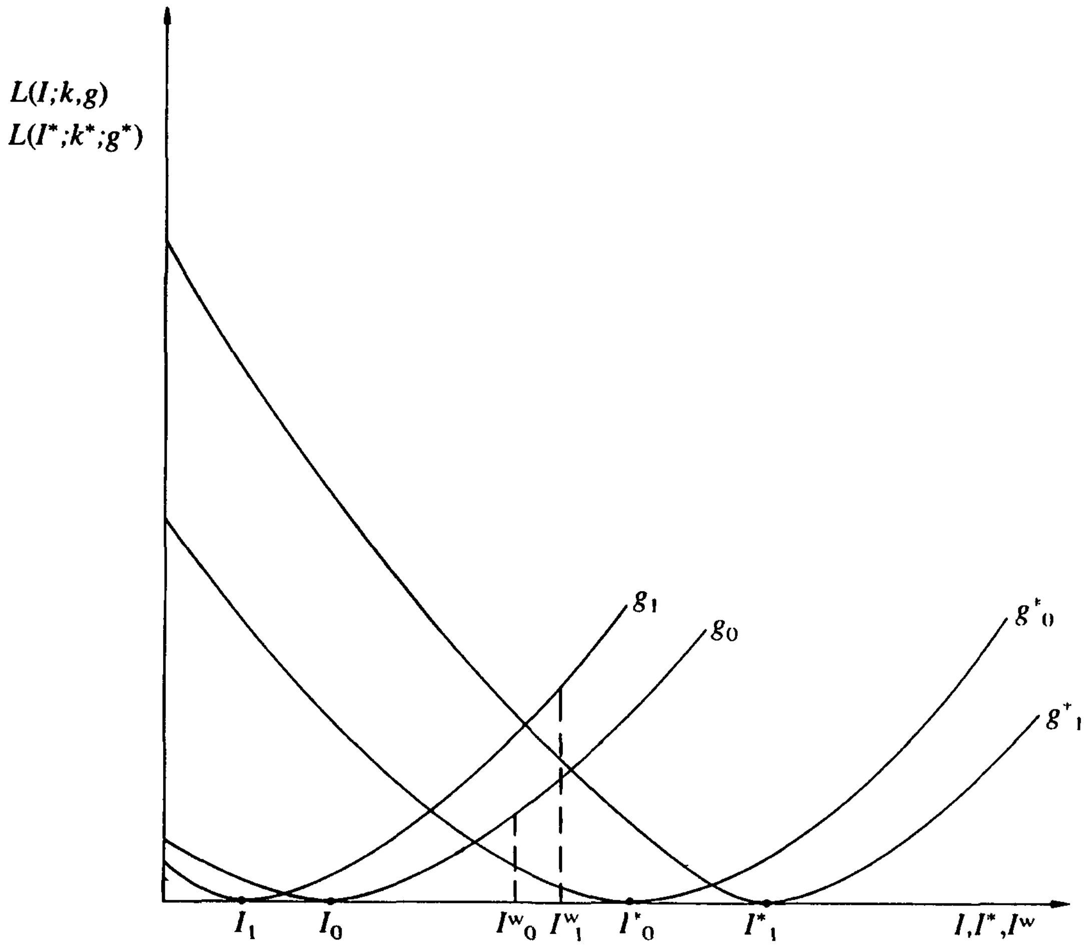


Table 1. Effects of Increasing Government Spending in the High-Collection-Cost Country While Decreasing it in the Low-Collection-Cost Country

$g^* - g$	α	i^w	i^*	i	s^*/g^* EMS	s^*/g^* ind.	s/g EMS	s/g ind.
0=24-24	0.548	3.89	6.44	0.66	2.17	3.34	2.17	0.40
2=25-23	0.568	4.17	6.71	0.63	2.22	3.32	2.41	0.40
4=26-22	0.588	4.46	6.98	0.60	2.26	3.29	2.67	0.41
6=27-21	0.609	4.77	7.26	0.58	2.31	3.27	2.97	0.41
8=28-20	0.630	5.09	7.53	0.55	2.35	3.25	3.29	0.41
10=29-19	0.651	5.42	7.81	0.52	2.40	3.23	3.66	0.41

1/ In all three tables, all figures, except for g, g*, and α are in percentage terms. The values of g and g* are multiplied by 100 to save space.

Table 2. Effects of Increasing Government Spending in the Low-Collection-Cost Country While Increasing it in the High-Collection-Cost Country

$g - g^*$	α	i^w	i^*	i	s^*/g^* EMS	s^*/g^* ind.	s/g EMS	s/g ind.
0=24-24	0.548	3.89	6.44	0.66	2.17	3.34	2.17	0.40
2=25-23	0.529	3.62	6.26	0.69	2.13	3.36	1.96	0.40
4=26-22	0.510	3.37	5.89	0.71	2.08	3.39	1.76	0.40
6=27-21	0.492	3.13	5.62	0.74	2.04	3.41	1.59	0.40
8=28-20	0.475	2.91	5.35	0.77	2.00	3.44	1.43	0.40
10=29-19	0.460	2.70	5.08	0.80	1.97	3.46	1.29	0.40

extreme situation, yields α=0.525. The overall conclusion that results from the numerical exercises is that what really matters for the inflationary bias is the difference in the values of k; namely, the relative efficiency of the tax administration system in both countries. The differences in the values of k impart an inflationary bias to the system. Differences in levels of government spending matter as long as the values of k differ to begin with; otherwise they have little effect and the common optimal nominal interest rate is very close to the average of the two optimal nominal interest rates under flexible exchange rates.

Table 3. Effects of Increasing Differences in Government Spending for the Same Values of k

					s^*/g^*		s/g	
g^* - g	α	i	i	i	EMS	ind.	EMS	ind.
0=24-24	0.500	3.58	3.58	3.58	2.01	2.01	2.01	2.01
2=25-23	0.501	3.58	3.73	3.43	1.94	2.00	2.11	2.02
4=26-22	0.502	3.60	3.89	3.28	1.87	2.00	2.21	2.03
6=27-21	0.508	3.64	4.03	3.13	1.81	1.99	2.34	2.04
8=28-20	0.515	3.69	4.18	2.98	1.77	1.98	2.48	2.05
10=29-19	0.525	3.75	4.33	2.82	1.74	1.97	2.65	2.06

As regards the revenues from seigniorage as a proportion of total revenues, it should be first pointed out that, as follows from the sub-columns labeled (s/g,ind.) and (s^*/g^*,ind.), the relative importance of seigniorage relative to total revenues under flexible rates is a decreasing function of government spending, even when the optimal inflation tax is an increasing function of government spending. For example, in Table 1, we observe that as g^* increases the share of seigniorage in total revenues declines from 3.34 percent to 3.23 percent while at the same time the optimal inflation tax increases from 6.44 percent to 7.81 percent. 1/ Interestingly enough, however, both in Table 1 and 2, the restriction imposed by having a common inflation tax reverses this result; in Table 1, as i^w increases, the share of revenues from the inflation tax increases in both countries as follows from the

1/ Végh (1988) shows for different values of k that, given this specification of the model, the share of revenues from the inflation tax in total revenues is always a decreasing function of government spending. Obviously, this implies that the share of revenues from the consumption tax increases as government spending rises.

columns labeled $(s^*/g^*, \text{EMS})$ and $(s/g, \text{EMS})$, notwithstanding the fact that g^* is increasing while g is decreasing. The same happens in Table 2 where the share of revenues from seigniorage falls as i^W declines independently of what is happening to g and g^*. Therefore, the two-country model of optimal taxation under fixed-exchange rates reverses, under the same specification, the result mentioned above obtained by Végh (1988a) for one-country models or, which amounts to the same, for two-country models under flexible exchange rates.

IV. The Two-Country Model With a Common Consumption Tax

There is an ongoing discussion, within the general liberalization measures contemplated for 1992 in the EMS, concerning the harmonization of tax rates across countries. The consequences that these tax measures could have on national inflation rates is not usually at the center of policy discussions but a moment's reflexion should make it clear that these effects deserve, at the very least, to be looked upon in order to assess whether they might be important or not. The reason why the effects of tax harmonization could have important implications is that if it were the case that such measures tended to increase the spread between national inflation rates, the need for periodic realignment would increase. Given the impossibility of resorting to capital controls at the time of a devaluation crisis, large changes in domestic interest rates would be needed to prevent a flight from the weaker currency. This section examines the impact of consumption tax harmonization (which, for the purposes of this paper, is taken to mean consumption tax equalization) on national inflation rates.

From the consumer's maximization presented in Section II, V(q) and $V(q^*)$ result, where $q^*=(1+\theta^W)\{1+v(X)+IX\}$ and $q^*=(1+\theta^W)\{1+v(X^*)+I^*X\}$. Note that, unlike the case studied in Section III, the nominal interest rates may be different while the consumption tax, denoted by θ^W, is the same in both countries. The optimization problem faced jointly by the authorities of both governments is given by:

$$\underset{\{\theta^W,\ I,\ I^*\}}{\text{Maximize}} \quad V(q) + V(q^*)$$

subject to:

$$g = c[(1-k\theta^W c)\theta^W + IX(1+\theta^W)] \tag{13}$$

$$g^* = c^*[(1-k^*\theta^W c^*)\theta^W + I^*X^*(1+\theta^W)] \tag{14}$$

In addition to (13) and (14), the optimality condition for this problem is

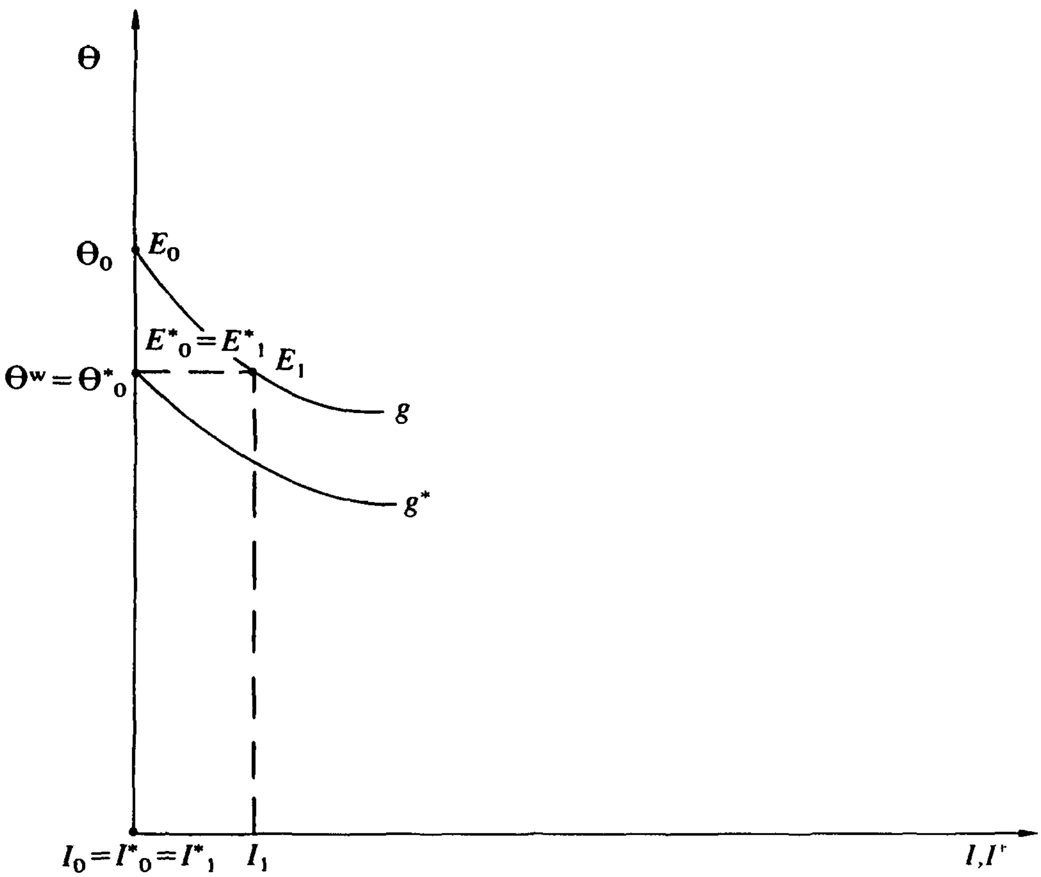
$$\frac{V_q c\left[q_I \Gamma_{\theta^w} - q_{\theta^w} \Gamma_I\right]}{c_q q_I \Gamma + c\Gamma_I} = \frac{-V_{q^*} c^*\left[q^*_{I^*} \Gamma^*_{\theta^w} - q_{\theta^w} \Gamma^*_{I^*}\right]}{c^*_{q^*} q^*_{I^*} + c^* \Gamma^*_{I^*}} \tag{15}$$

As was the case in Section III, the terms in square brackets, denoted by D and D^* respectively, would be zero if the constraint $\theta = \theta^* = \theta^w$ were not binding because optimality, under flexible exchange rates, requires that $D = D^* = 0$. When the constraint $I = I^* = I^w$ was imposed in the problem in Section III, the solution was $I^w = 0$ when $k = k^* = 0$. Interestingly enough, this is no longer the case when the constraint $\theta = \theta^* = \theta^w$ is imposed. It can be readily checked that, even when $k = k^* = 0$, it is not optimal for <u>both</u> I and I^* to be equal to zero. For suppose this were the case; then condition (15) would hold (because $D = D^* = 0$) but equations (13) and (14) would imply that unless $g = g^*$ (in which case both countries would share the same parameters) the system is inconsistent because if $I = I^* = 0$ then $c = c^*$ so that $g = \theta^w c$ and $g^* = \theta^w c^*$ cannot hold simultaneously. A graphical analysis of the optimal solution leads to the conclusion that a corner solution takes place (namely, condition (15) holds as an inequality) as illustrated by Figure 4, where for simplicity only the iso-revenue curves have been drawn. Points E_0 and E_0^* denote the optimal taxation policies of the domestic and foreign country, respectively, under flexible exchange rates. Due to the non-negativity constraint on the nominal interest rate, it follows that the common consumption tax, θ^w has to be at, or below, point E_0^*. It should be clear that θ^w cannot be below θ^* because the welfare of both consumers would decrease by moving beyond E_1^* along g^* and moving beyond point E_1 along g. Therefore, the optimum θ^w is equal to θ^*. The optimal taxation structure of the foreign country thus remains at E_0^* (that is, $E_0^* = E_1^*$) while that of the domestic country takes place at point E_1. The outcome of imposing the constraint of equating the consumption tax thus brings about two interesting results. First, the optimal taxation structure of the foreign country does not change. Second, even in the absence of collection costs, the domestic country finds it optimal to resort to inflationary finance. Naturally, all the cost of equalizing consumption taxes is borne by the domestic country. 1/ This case also provides a clear example of how the equalization of consumption taxes may cause national inflation rates to diverge, given that in the initial situation they were both zero, thus not only producing a higher average

---

1/ Again, the analysis begs the question of why would the foreign country willingly engage in equalization of consumption taxes, to begin with. As has been indicated in the Introduction, however, the analysis abstracts from the potential benefits of tax harmonization.

Figure 4. Effects of Equalizing Consumption Taxes on Inflation Taxes when $I_0 = I^*_0 = 0$



inflation rate but also making it more difficult to sustain fixed parities. 1/

It is of interest to simulate the model for the cases of Italy and Germany referred to in Section III to see what would be the effects on the national inflation rates of equalizing the consumption tax. Figure 5 illustrates this case. The initial equilibrium of Germany is at point E_0 with a very low inflation rate and a lower consumption tax rate as well. Point E_0^* represents the initial equilibrium of Italy. If the constraint of equal consumption taxes is imposed, the simulations show that a corner solution takes places at point E_1 for Germany. This means that the inflation of Germany would fall to zero (in spite of its positive value of k) while that of Italy would increase to point I_1^* from point I_0^*. Therefore, given the specification of the model and the initial equilibrium that roughly reproduces the German and Italian fiscal structures, the optimal outcome is for Germany to achieve a zero inflation tax and for Italy to increase its inflation tax so that a divergence of national inflation rates would result. The reasoning leading to the conclusion that the optimal θ^w equals θ_0 is simple enough. If the non-negativity constraint on the nominal interest rates were not imposed, the simulations indicate that the optimal θ^w would lie between the intersection of both iso-revenues with the Y-axis. The best the authorities can do, given the non-negativity constraint, is to choose point θ^w. Clearly, the costs borne by Germany would be less than those borne by Italy since the unconstrained optimal tax structure of Germany has a nominal interest rate of only 0.6 percent (that is, practically zero) to begin with.

Figures 6 through 9 illustrate different outcomes that could result from equalizing the consumption tax. The different cases are presented according to whether there exists convergence or divergence of the initial inflation taxes and to whether there exists reversal or not (the existence of reversal means that the country that initially has the lowest inflation tax ends up with the highest). Figure 6 depicts the case where there is divergence of the initial inflation taxes but no reversal. Initially, both the consumption and the inflation tax are higher in the foreign country. These initial taxes could result, for instance, from $k = k^*$ and $g^* > g$ but many other parameter configurations could yield the same outcome as well. When the consumption tax is equalized at θ^w, it can be observed that I^* increases while I decreases so that the difference between the inflation rates rises. Figure 7 illustrates the case where divergence with reversal results. This situation can arise when the domestic country has the lowest inflation tax but the highest consumption tax. Figure 7 depicts a situation where the iso-revenue of the domestic country lies above that of the foreign

1/ It is not the case, however, that a corner solution necessarily implies the divergence of the nominal interest rates when one or both of the countries have positive values of k, as the reader can easily verify graphically.

country. This could result, for instance, from $g>g^*$ and $k<k^*$. When the consumption tax is equalized, the salient feature is that the initial order of magnitude of the inflation taxes is reversed; namely, the domestic country now has the higher inflation rate. The difference between the initial inflation taxes can decrease as is the case in Figure 7 but it could also increase as it happens in Figure 8 which represents the same initial configuration of Figure 7. 1/ Figure 9 illustrates the case where the initial situation is the same as in Figure 6 (the first case) but, because of the fact that the iso-revenues intersect, the result of equalizing the consumption tax is a convergence of the nominal interest rates. For the iso-revenue curves to intersect it is necessary that the country with the highest level of government spending have the lowest level of k. 2/

Other simulations were undertaken to verify that the theoretical cases that have been discussed could indeed occur given the particular specification of the model. As the reader will notice from Table IV, the values of g and g^* have to be quite close to avoid the corner solutions that have already been discussed. Because of the importance, as regards total fiscal revenues, of the revenues from the consumption tax, any difference between levels of public spending that requires substantially different consumption tax is likely to lead to a corner solution because the country whose consumption tax increases generates too much revenue which, if negative inflation tax were allowed, would be transferred back to the public.

1/ There is a third case where the iso-revenue of the foreign country lies above that of the domestic country, as is the case in Figure VI but now the domestic country has a lower consumption tax. As the reader can readily check, the result of equalizing the consumption tax would be convergence of the nominal interest rates and, unlike the case of Figure VII and VIII, there would be no reversal. Simulations suggest, however, that this initial equilibrium is very unlikely to take place because the country with the highest level of public spending usually has the highest consumption tax so that this case can be ruled out. Intuitively, the reason for the implausibility of this initial equilibrium lies in the fact that since the revenues from the consumption tax account for over 90 percent of total revenues (this should be interpreted, in thinking about the EMS, as revenues from sources other than the inflation tax), a higher level of public spending requires a higher consumption tax in order to finance it.

2/ It should be clear that both an increase in g or k have to shift the iso-revenue upward; namely, the new iso-revenue cannot cross the old one. Suppose k increases while g remains constant, if both iso-revenues were to intersect it would mean that at the intersection point the same revenue is being raised in spite of the higher collection costs which is not possible. Suppose g rises while k remains unchanged, if both iso-revenue curves intersected it would mean that, at the intersection point, the taxes would yield too much revenue for the old level of g or too little for the new level of g.

Figure 5. Equalizing Consumption Taxes: the Effects on the Inflation Taxes of Germany and Italy

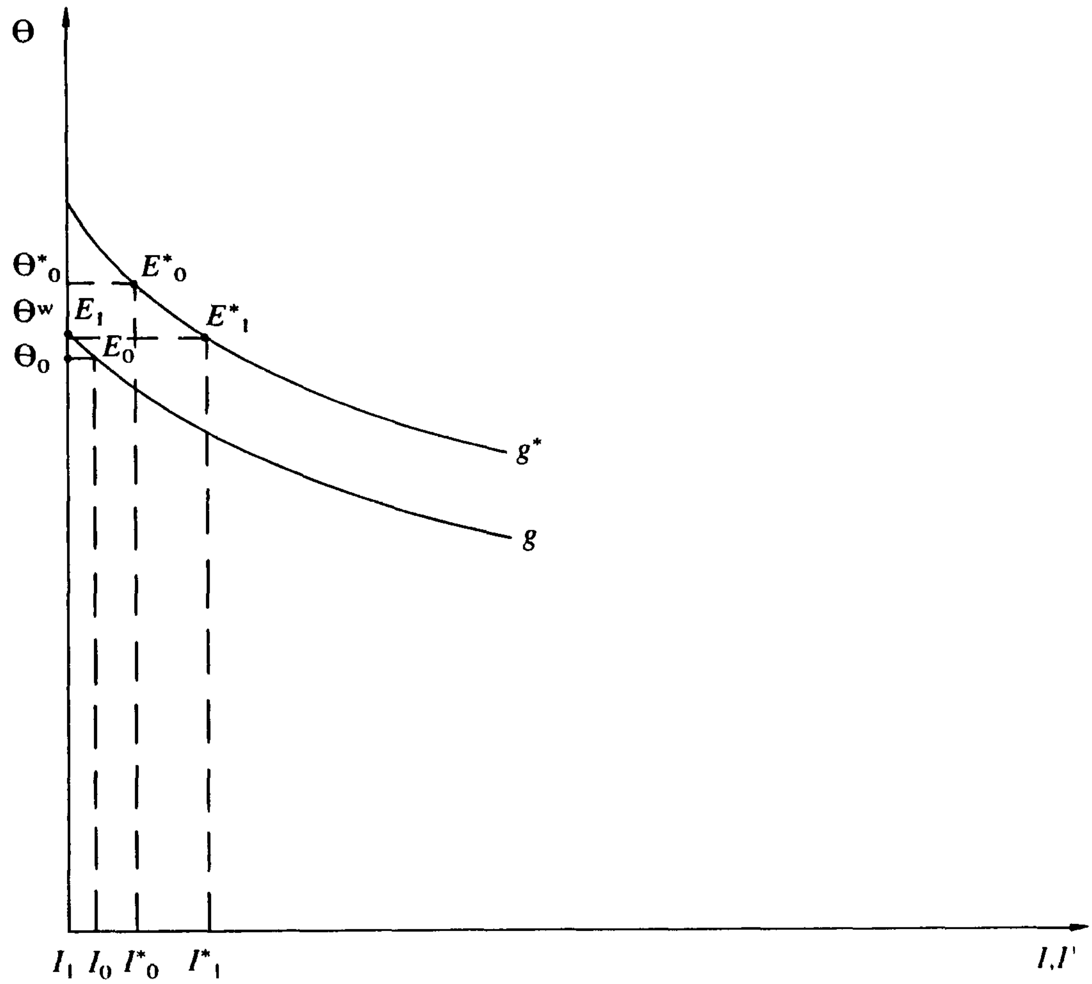


Figure 6. Effects of Equalizing Consumption Taxes on Inflation Taxes: the Case of Divergence with no Reversal

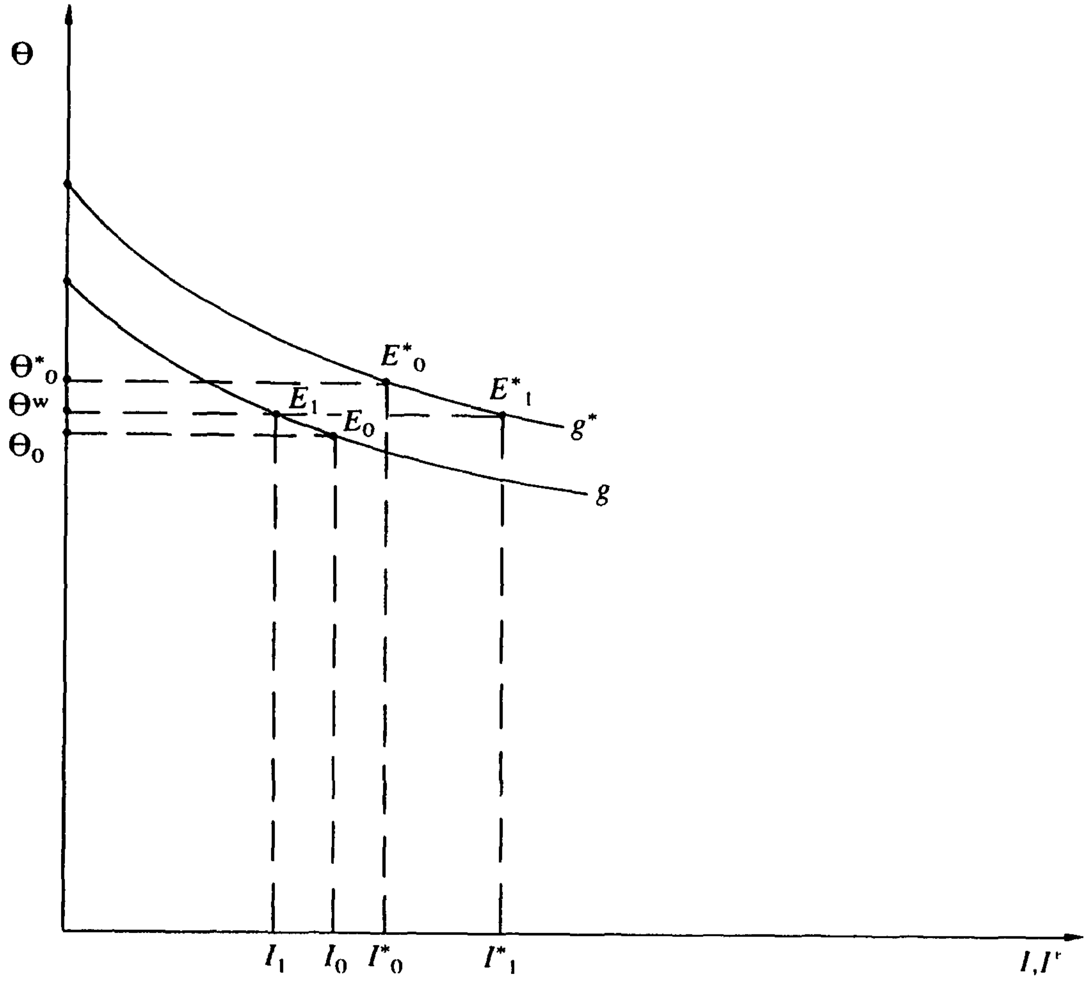


Figure 7. Effects of Equalizing Consumption Taxes on Inflation Taxes: the Case of Divergence with Reversal

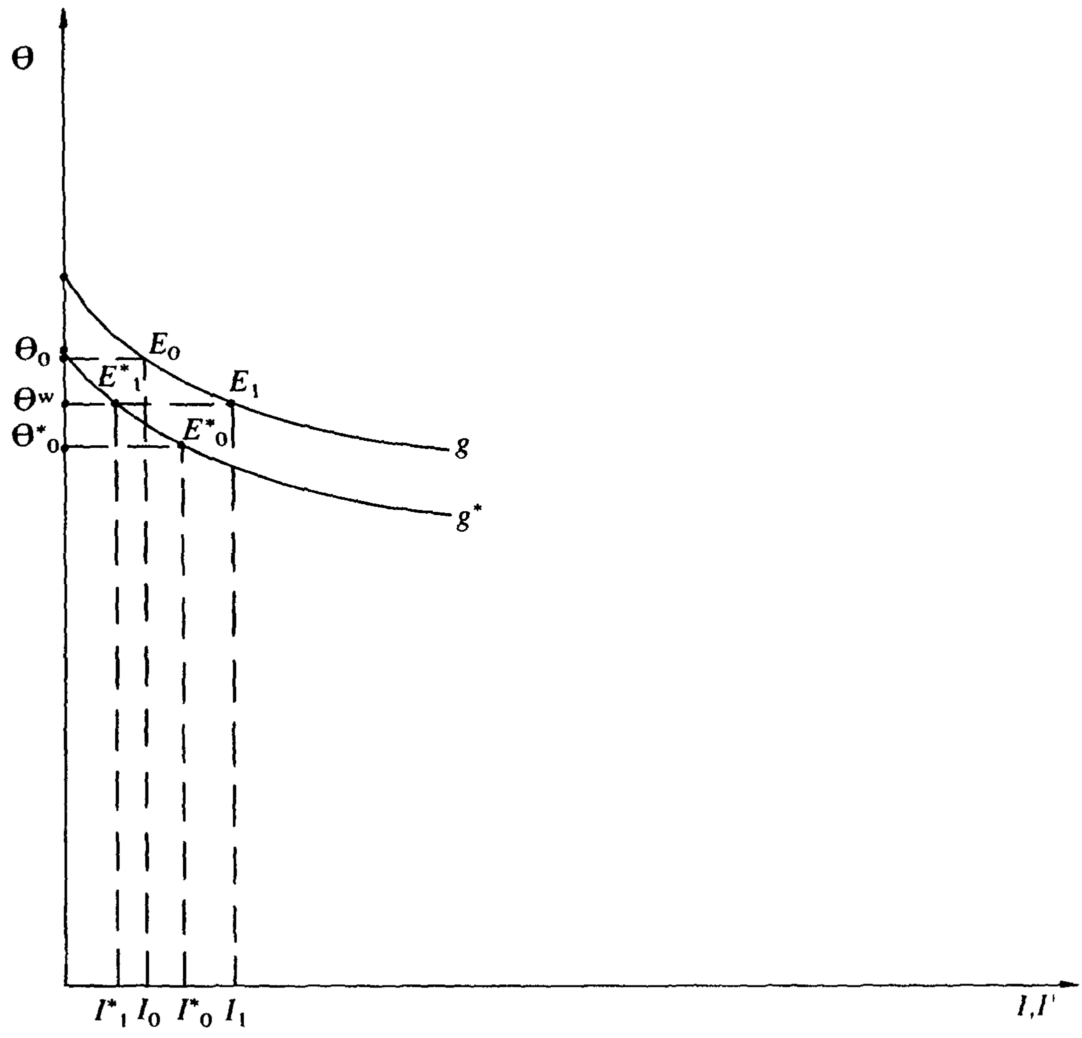


Figure 8. Effects of Equalizing Consumption Taxes on Inflation Taxes: the Case of Convergence with Reversal

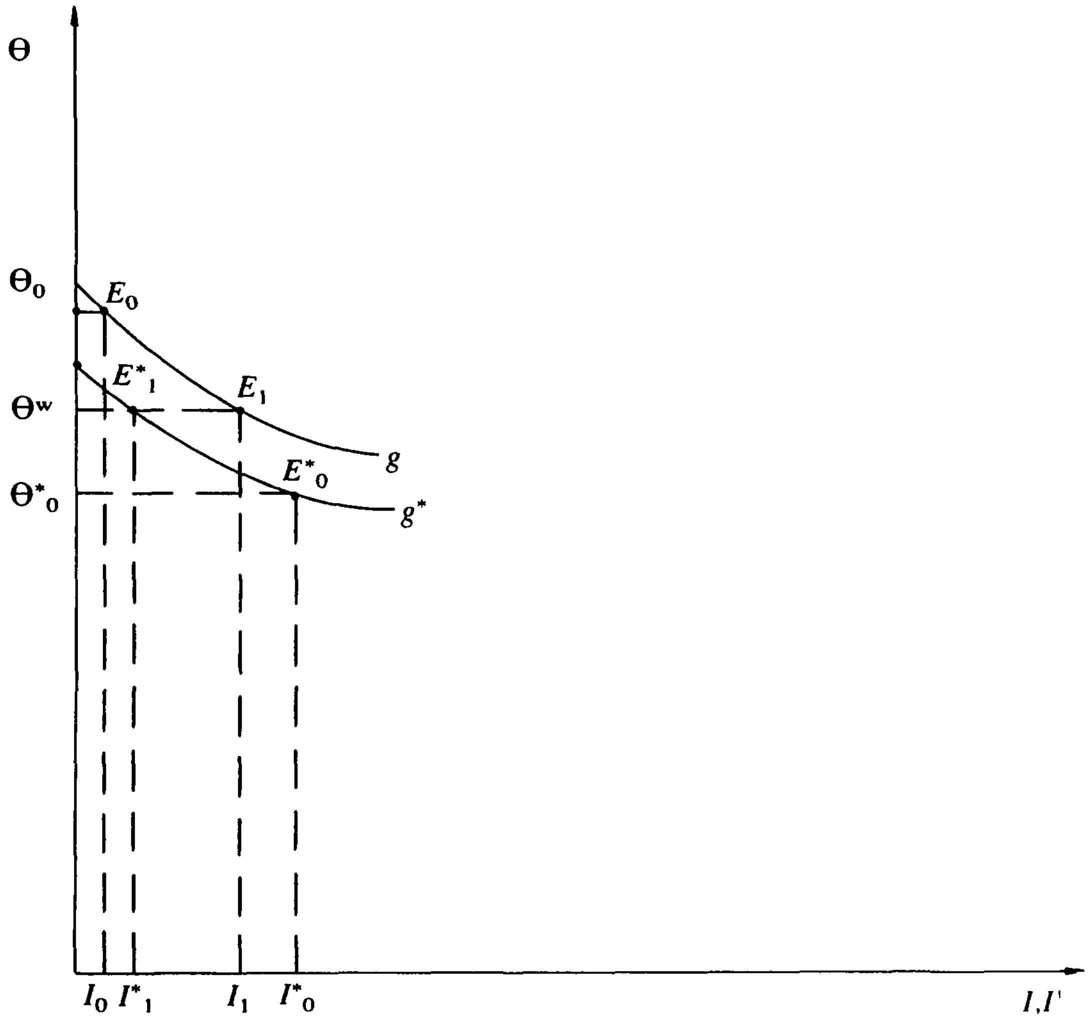


Figure 9. Effects of Equalizing Consumption Taxes on Inflation Taxes: the Case of Convergence with no Reversal

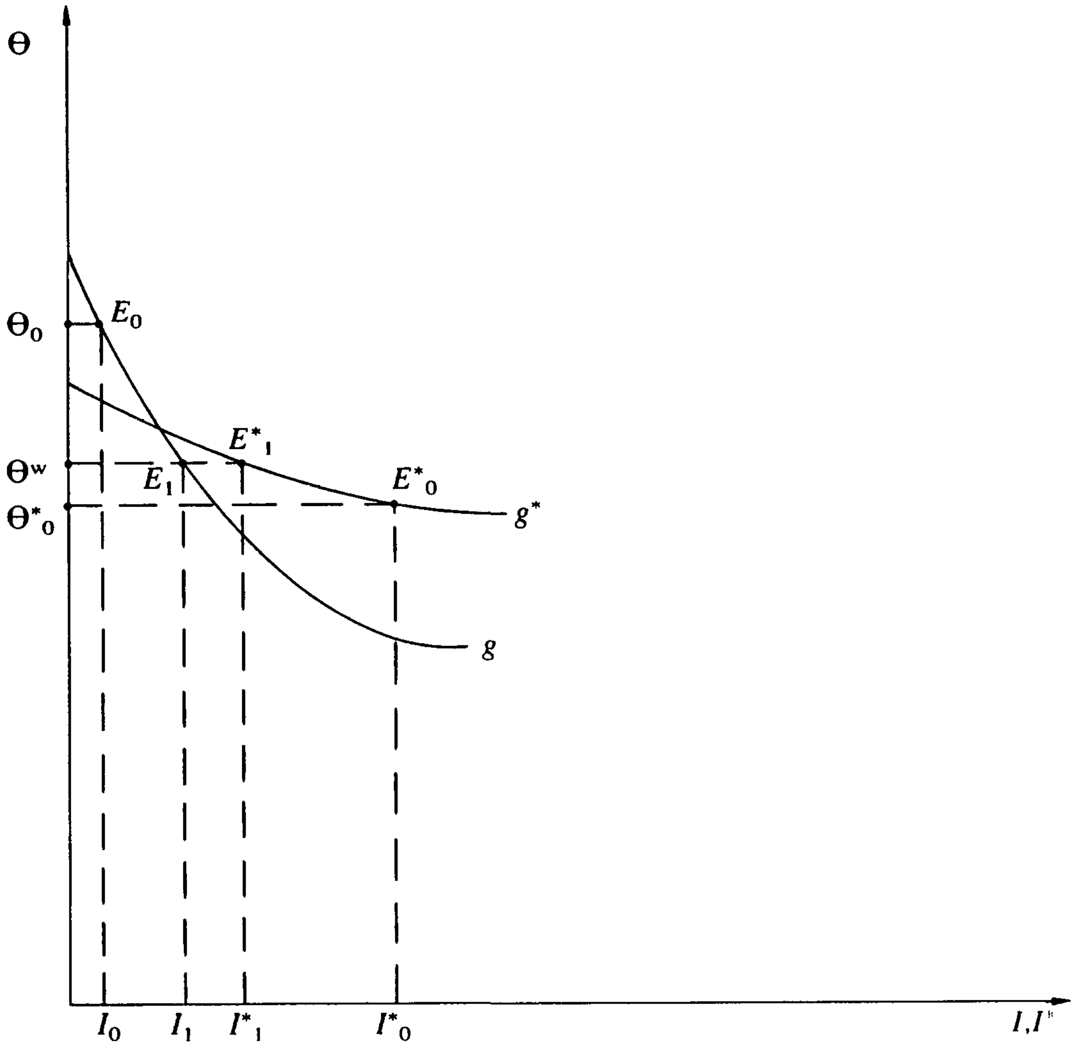


Table 4 presents simulated cases that correspond to the theoretical ones discussed above. The simulation thus shows that each of those cases can indeed be the optimal outcome of equalizing the consumption tax with the particular specification adopted. There are four cases presented in Table 4, each of which takes three lines. In the first and second line of each case, the individual cases are presented. In the third line the optimal tax structure, once the constraint of equal consumption taxes is imposed, is shown. The only new symbols are i^c and $(i^*)^c$ which stand for the optimal nominal interest of the constraint optima. Thus, lines 1-3 exemplify Figure 6; lines 4-6 Figure 7, lines 7-9 Figure 8, and lines 9-12 Figure 9.

The predictions of the model as to the likely consequences of an equalization of the consumption tax are quite sensible to the parameter specification. In general, the nominal interest rates are quite sensible to any change in parameters making the occurrence of corner solutions quite common. The sensibility of the nominal interest rates should not be surprising given that revenues from seigniorage account for only a small fraction of total government revenues. This implies that large movements in nominal interest rates are needed to compensate for small changes in the consumption tax that cause a dramatic change in revenues.

It should be borne in mind that, in attempting to use this theoretical framework to think about the EMS, the revenues from the consumption tax should be thought of as fiscal revenues from any source other than the inflation tax. This implies that the experiment undertaken in this section is quite strong in the sense that it would imply the equalization of all tax rates (VATs, income taxes, and so forth) currently used in the EMS. The usefulness of conducting such an extreme experiment lies in that it suggests that dramatic changes could come about if the EMS began to move in the direction of a broad-based tax harmonization which suggests that caution should be exercised in taking such steps in account of the considerations analyzed in the present context. The key problem derives from the fact that, given different revenue needs in different countries, the equalization of a wide range of taxes would provide little room for maneuver for those countries that need more or less revenue than the "average" country. These results should also be viewed as "food for thought" in that they should call the attention of both researchers and policy-makers to issues that would have hardly come to mind had a theoretical framework not called our attention to them.

V. Conclusions

This paper has analyzed, within a framework where the government has to resort to distortionary taxes to finance a given stream of government spending, how different constraints that are likely to emerge from the liberalization process taking place in the EMS would affect the optimal way in which governments finance their spending. To accomplish that, a two-country model of optimal-inflation-tax models was developed, analyzed, and simulated to gain further insights into the issues involved.

Table 4. Equalization of Consumption Taxes: Possible Outcomes

	g	g^*	k	k^*	θ	i	θ^*	i^*	θ^w	i^c	$(i^*)^c$
1.	0.1975		0.25		68.5	5.73					
2.		0.2025		0.25			71.6	5.88			
3.	0.1975	0.2025	0.25	0.25					70.6	1.41	9.03
4.	0.205		0.125		71.2	3.01					
5.		0.195		0.25			67.0	5.6			
6.	0.205	0.195	0.125	0.25					69.6	7.08	0.36
7.	0.203		0.125		70.0	2.99					
8.		0.197		0.25			68.2	5.72			
9.	0.203	0.197	0.125	0.25					69.1	4.95	3.64
10.	0.2025		0.125		70.0	2.98					
11.		0.1975		0.25			68.5	5.72			
12.	0.2025	0.1975	0.125	0.25					69.1	4.29	4.42

Lines 1-3: divergence with no reversal (Figure 6); lines 4-6: divergence with reversal (Figure 7); lines 7-9: convergence with reversal (Figure 8); lines 10-12: convergence with no reversal (Figure 9). All taxes are expressed in percentage terms.

When the constraint of having to share a common nominal interest rate was imposed, it was shown that the costs of so doing are likely to be small given reasonable parameter values for EMS countries. This model therefore would suggest that policy-makers need not worry about the possible fiscal consequences of requiring a convergence of monetary policies to make realignments much less likely than in the past.

On the other hand, the picture that emerges from the equalization of consumption taxes is mixed. Depending on the initial parameter configuration, equalizing most conventional taxes could lead to divergences in the national inflation rates which would make it more difficult to sustain fixed parities. This model thus suggests that caution and further study of the issue are warranted.

Finally, the reader should keep in mind that the purpose of this paper has been to isolate the public finance aspects of the different issues considered. This should help in understanding the implications of public finance considerations and, in turn, how they may relate to other macro-economic issues which will clearly interact with the ones discussed here. One of the ways in which economic theory can be of help in the actual design of policies, is in suggesting the key elements behind, potentially crucial, consequences of different policy measures.

References

Aizenman, Joshua, "Inflation, Tariffs, and Tax Enforcement Costs," Journal of International Economic Integration (Autumn 1987), pp. 12-28.

Auernheimer, Leonardo, "The Honest Government's Guide to the Revenue from Money Creation," Journal of Political Economy, Vol. 82 (Chicago, 1974), pp. 598-606.

Giavazzi, Francesco, and Alberto Giovannini, "Limiting Exchange Rate Flexibility: The European Monetary System," unpublished manuscript (1988).

Gros, Daniel, "Seigniorage in the EC: The Implications of the EMS and Financial Market Integration," unpublished manuscript (1988).

Guidotti, Pablo, and Carlos Végh, "The Optimal Inflation Tax when Money Reduces Transactions Costs: A Reconsideration," unpublished manuscript (1988).

Guitián, Manuel, "The European Monetary System: A Balance Between Rules and Discretion," Part I of Policy Coordination in the European Monetary System, Occasional Paper 61 (Washington: International Monetary Fund, 1988).

Kimbrough, Kent, "The Optimum Quantity of Money Rule in the Theory of Public Finance," Journal of Monetary Economics, Vol. 18 (1986), pp. 277-284.

Lucas, Robert Jr., and Nancy Stokey, "Optimal Fiscal and Monetary Policy in an Economy without Capital," Journal of Monetary Economics, Vol. 12 (1983). pp. 55-93.

Obstfeld, Maurice, and Alan Stockman, "Exchange Rate Dynamics," in Handbook of International Economics, Vol. 2, ed. by Ronald Jones and Peter Kenen (Amsterdam: North Holland, 1985), pp. 917-997.

Phelps, Edmund, "Inflation in the Theory of Public Finance," Swedish Journal of Economics, Vol. 75 (1973), pp. 67-82.

Russo, Massimo, and Giuseppe Tullio, "Monetary Coordination Within the European Monetary System: Is There a Rule?" Part II of Policy Coordination in the European Monetary System, Occasional Paper 61 (Washington: International Monetary Fund, 1988).

Végh, Carlos, "On the Effects of Currency Substitution on the Optimal Inflation tax and on the Response of the Current Account to Supply Shocks," doctoral dissertation (University of Chicago, 1987).

_____, "Government Spending and Inflationary Finance: A Public Finance Approach," Working Paper No. WP/88/98 (Washington: International Monetary Fund), forthcoming Staff Papers (1989).

_____, "The Optimal Inflation Tax in the Presence of Currency Substitution," forthcoming Journal of Monetary Economics (1989).

Wyplosz, Charles, "Capital Flows Liberalization and the EMS: A French Perspective" (France: INSEAD, 1987).