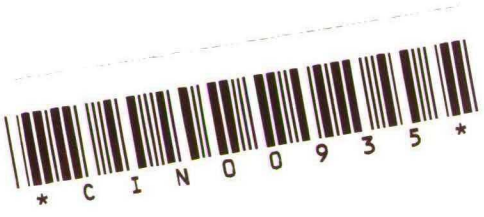
Is the European Community an Optimal Currency Area?

Canzoneri, M.; Rogers, C.

Publication date:
1989



No. 8923

IS THE EUROPEAN COMMUNITY AN OPTIMAL CURRENCY AREA? OPTIMAL TAX SMOOTHING VERSUS THE COST OF MULTIPLE CURRENCIES

by Matthew B. Canzoneri
and Carol Ann Rogers

May, 1989

IS THE EUROPEAN COMMUNITY AN OPTIMAL CURRENCY AREA?

OPTIMAL TAX SMOOTHING VERSUS THE COST OF MULTIPLE CURRENCIES*

by

Matthew B. Canzoneri

and

Carol Ann Rogers

Georgetown Universiy
Washington, D.C. 20057

November, 1988
Revised May, 1989

*We wish to thank Hans Genberg, Kent Matthews, Patrick Minford, Alan Stockman, Lars Svensson and Paul Wood for useful discussions of the work presented here. We would also like to thank seminar participants at the CentER for Economic Research in Tilburg, the University of Chicago, New York University, Indiana University, and Georgetown University. None of them bears any responsibility for what follows.

The European Community seems to be moving rapidly toward economic integration. Barriers to trade in goods and financial assets are to come down by 1992. However, the fate of the European Monetary System seems to be in some doubt, especially in light of the elimination of capital controls. Without capital controls, the maintenance of fixed exchange rates may require convergence in monetary policy and inflation rates. Should the emergence of a single European currency be part of the 1992 agenda? We would like to suggest a new way of looking at this question.

Over the last fifteen years, arguments for fixed exchange rates have focused on stabilization problems created by sticky prices or on inflation problems caused by policymakers' lack of credibility.[1] Sticky prices were thought to imply adjustment costs, and the case for fixed rates was analyzed along the lines of Poole (1970) or along the game theoretic lines of Canzoneri and Gray (1985). Alternatively, it was argued that "weak" policymakers could combat inflationary expectations by tying their currencies to a more stable currency; credibility problems were analyzed along the lines of Barro and Gordon (1983). In this paper however, we eschew all problems associated with sticky prices or policymaker credibility, and assume that prices are market-determined and that European policymakers cooperate with each other and are believed by the private sector. We do not mean to suggest that these problems are irrelevant; we do mean to focus attention on a neglected aspect in the determination of optimal currency areas.

Our basic purpose here is to present a view of optimal currency areas that is based on the principles of public finance.[2] The seignorage tax is one among many distortionary taxes that can be imposed to raise revenue. As Table 1 shows, some countries raise a substantial proportion of their revenue through

seignorage while others raise very little. Why does Italy depend so heavily on the seignorage tax, while Germany does not? The public finance literature provides one answer. Tax rates should to be set to smooth out distortions. Optimal tax rates will depend upon the menu of taxes a government can impose; goods and services that are taxed in one region may be beyond the tax collectors reach in another. Optimal tax rates will also depend upon the supply and demand elasticities of the goods taxed. There is no reason to think that the optimal inflation tax in Germany will be the same as that in Italy. For that matter, there is no reason for the optimal inflation tax in southern Italy to be the same as that in northern Italy. In any case, the implications of the principles of public finance seem clear. Regions that require the same inflation tax may form an optimal currency area.

Since countries have different menus of taxes, and even within a single country different regions may exhibit very different supply and demand elasticities, one might expect that the public finance view will call for many different inflation taxes, dividing the world into many small regions. As Mundell (1961) has observed, this does not appeal to common sense. (Mundell originated the stabilization view of optimal currency areas, but worried that it would call for many small regions.) Nor does it accord with a long-held view that trade in many currencies is intrinsically costly, so that currency areas should be large. Mundell writes (p. 662):

> ...It will be recalled that the older economists of the nineteenth century were internationalists and generally favored a world currency. ...Mill, like Bagehot and others, was concerned with the costs of valuation and money-changing, not stabilization policy, and it is readily seen that these costs tend to increase with the number of currencies. Any given money qua numeraire or unit of account fulfills this function less adequately if the prices of foreign goods are expressed in terms of foreign currency and must then be translated into domestic currency prices. Similarly, money in its role of medium of exchange is less useful if there are many currencies; although the

> costs of currency conversion are always present, they loom exceptionally large under inconvertibility or flexible exchange rates.

Similar notions have been expressed by those who favor a continuation of the EMS or the creation of a single European currency, though the actual cost of multiple currencies has never been measured.[3]

Thus, we come to the factors we will consider in drawing the boundaries of an optimal currency area.[4] Multiple currencies allow separate inflation rates in each country or region, and this flexibility may well produce tax smoothing efficiencies. However, these benefits must be weighed against the valuation and currency conversion costs that are introduced by the multiplicity of currencies.

To illustrate this tradeoff, we construct a two country model of what we call the "EC". We give "Italy" tax smoothing reasons to opt for high inflation; we model "Germany" as a low inflation country. From the public finance point of view, the EC is not an optimal currency area. However, we also model valuation and currency conversion costs, costs that can be eliminated if Italy and Germany eschew their separate currencies and adopt a single European currency, the "ECU". The EC is an optimal currency area if the costs of multiple currencies outweigh the benefits of tax smoothing.

In section I, we outline our model of the EC. The model is essentially a two country version of the model used by Lucas (1987) and Lucas and Stokey (1987). Each country is populated by infinitely-lived households that consume home cash goods, home credit goods and foreign credit goods; the cash good is subject to a cash in advance constraint. Each country has a given level of public spending that must be financed through seignorage or taxation. We model only one asymmetry between the countries: Italy has a black market that cannot be taxed directly, while Germany has no black market, and all German income is

subject to an income tax. The black market good is modeled as a "cash" good. So, Italy can use inflation to tax its black economy indirectly.[5]

The model comes in two versions. In the first, each country has its own currency, and doing business with two currencies wastes resources. Each country is endowed with labor that can be converted one for one into cash goods or home credit goods; additional resources must be expended if the credit good is sold to a foreigner. These costs reflect the time and effort it takes to quote prices in a foreign currency and to convert the proceeds back into domestic currency. In the second version of the model, Europe has only one currency, and selling to a foreigner implies no additional costs.

In section II, we give a formal definition of the optimal currency area problem. The EC policymaker's problem is to choose the number of currencies and to set the available tax rates to maximize a weighted sum of the utilities of Italian and German households.

In section III, we find the best outcome that can be achieved if the two currencies are retained. With two currencies, the EC policymaker has enough taxes to achieve an efficient outcome. The optimal tax rates have to make the relative price of cash and credit goods in each country equal to one, the rate of transformation in production. In Italy, the inflation tax on cash goods (the black economy) must balance the sales tax on credit goods. Germany's income tax is not distortionary; however, the relative price of cash and credit goods will be distorted if the German nominal interest rate is greater than zero, since money must be held in lieu of bonds to purchase a cash good. It turns out that the optimal inflation rate is equal to minus the time rate of preference, as Friedman has suggested. From a public finance point of view, the EC is not an optimal currency area. Any EMS constraint that makes Italian

and German inflation rates converge must decrease welfare in one country or the other.

The relevance of our way of modeling the tax smoothing problem depends upon the importance of the black market in Italy. Table 2 presents estimates of the relative size of the black economy in various countries; the estimates vary widely, but Italy's black economy appears to be two or three times the size of black economies in other European countries. One might conclude that Italy does indeed have more reason to resort to the inflation tax. Of course, we do not mean to suggest that the black economy is Italy's only reason for running a high inflation rate. Italy could differ from Germany in a number of ways that, according to the principles of public finance, ought to result in a higher inflation rate.

In section IV, we ask if the EC policymaker could do better by introducing a European currency. By adopting a common currency, Italy and Germany could eliminate the valuation and currency conversion costs associated with multiple currencies, but they could no longer run the independent inflation rates they need for optimal tax smoothing. The answer we obtain should be obvious. If government spending is high, then a lot of revenue must be raised, and the benefits of optimal tax smoothing outweigh the extra costs associated with multiple currencies. The EC is not an optimal currency area. On the other hand, if the required revenues are more modest, then the EC can be an optimal currency area.

The complexity of our model finally drove us to use simulations to obtain the answer we have just given, but our investment in simulations did pay some empirical dividends. The valuation and currency conversion costs we describe must be rather small, and one might wonder whether the tradeoff we analyze is a

real concern. In our model, which is admittedly stylized and simple, we find that very small costs imply the EC is an optimal currency area.

Finally, in section V, we describe limitations of our analysis. We also make suggestions for future research.

I. A Simple Model of the EC

The model comes in two versions. In one version, each country has its own currency, while in the other, Europe has a single currency. We begin with the multiple currency version, and then explain how it has to be modified to get the single currency version.

There are only two countries in our stylized model of the EC: Italy and Germany. Italy is inhabited by identical, infinitely-lived households whose utility depends upon consumption of an Italian cash good, x, an Italian credit good, y, and a German credit good, z:

$$(1) \quad U = \Sigma_{t=0}^{\infty}\left[\frac{1}{1+\delta}\right]^{t} u(x_t, y_t, z_t).$$

Similarly, Germany is populated by identical, infinitely lived households whose utility depends on consumption of a German cash good, x*, a German credit good, y*, and an Italian credit good, z*:

$$(1)^{*} \quad U^{*} = \Sigma_{t=0}^{\infty}\left[\frac{1}{1+\delta}\right]^{t} u(x_t^{*}, y_t^{*}, z_t^{*}).$$

*'s denote German variables. Cash goods must be bought with cash, while credit goods are invoiced for payment later. We have modeled the foreign goods as

credit goods; so, we are thinking of a German's purchase of a Fiat, and not her vacation on the Italian Riviera.

Households are endowed with n units of labor each period. This labor can be converted one for one into home cash goods or home credit goods. If Italy and Germany have separate currencies, then producers incur extra resource costs when they sell to foreigners: $c > 1$ units of labor are needed to produce one credit good sold to a foreigner. If the EC adopts a single currency, then $c=1$. Thus, the resource constraints for Italy and Germany are

$$(2) \quad x_t + y_t + cz_t^* + g = n \qquad \text{and} \qquad x_t^* + y_t^* + cz_t + g^* = n^*.$$

g and g* are exogenously-determined rates of government spending in Italy and Germany.

The cash in advance framework and the distinction between cash goods and credit goods are borrowed from Lucas.[6] Each period begins with a financial exchange and ends with a goods market. In the financial exchange, households pay for the credit goods they purchased last period and acquire the cash they will need in the goods market that follows; governments collect taxes, pay interest on debt and issue new debt (in the form of money or bonds). In the goods market, households divide into worker-shopper pairs. Workers produce cash goods and credit goods; shoppers visit the workers of other households and buy goods. Shoppers must pay cash for the cash goods; credit goods are invoiced in the shopper's currency for payment in the next financial exchange. Between periods, households store the cash they received for the cash goods their workers produced. These cash balances are the base for the inflation tax.

Now we can be more explicit about the extra costs workers incur when there are multiple currencies. Credit goods are, by assumption, invoiced in the buyer's currency, and in the next period the payment for them comes in the buyer's currency.[7] A worker incurs two additional costs in selling credit goods to a foreigner. First, the worker has to value the good in another unit of account. Second, the foreign currency received must be converted into domestic currency, so that the household can purchase domestic cash goods. Both of these activities take time and effort, so we have modeled them as direct resource costs. They are our model's incarnation of the valuation costs and the brokerage fees described by Mundell and others.

Certain arbitrage conditions are immediate, and it will facilitate our discussion to take advantage of them. A worker will charge the same price for cash goods and home credit goods, since each takes one unit of labor to produce and the sale of either results in cash that cannot be used until the next financial period. Let p_t be the lira price of the Italian goods, and let p_t^* be the mark price of the German goods. What price will a worker charge a foreign shopper for a credit good? It takes c units of labor to produce a credit good for a foreigner, and the worker wants sales to all customers to result in the same cash value in the next financial exchange; so, letting e_t be the lira price of marks,

$$(3) \quad p_t^z = e_{t+1} p_t^* c \qquad \text{and} \qquad p_t^{z*} = (p_t / e_{t+1}) c$$

are the prices charged to Italian and German shoppers for foreign credit goods.

An Italian household's budget constraint for the financial exchange is

$$(4)\quad m_t + b_{It} + e_t b_{Gt} + \theta_t p_t (y_t + q_t z_t) \leq$$

$$R_{t-1} b_{It-1} + e_t R^*_{t-1} b_{Gt-1} + p_{t-1}(n - y_{t-1} - q_{t-1} z_{t-1})$$

On the left hand side, we have the household's acquisition of money and bonds and its tax payments. "I" subscripts denote Italian government bonds, which pay the gross nominal return R, and "G" subscripts denote German government bonds, which pay R*. The Italian government levies a sales tax, θ_t, on the household's purchases of domestic and foreign credit goods; q_t ($\equiv p^z_t/p_t$) is the relative price of the foreign credit good. The black economy is embodied in the Italian cash good; market transactions go unrecorded and untaxed. On the right hand side, we have the gross return on bonds purchased last period, plus receipts from last period's sales, minus payments for credit goods invoiced last period.

German households face a similar budget constraint:

$$(4)^* \quad m^*_t + b^*_{It}/e_t + b^*_{Gt} + \tau^*_t p^*_t n \leq$$

$$R_{t-1} b^*_{It-1}/e_t + R^*_{t-1} b^*_{Gt-1} + p^*_{t-1}(n^* - y^*_{t-1} - q^*_{t-1} z^*_{t-1}).$$

q^* ($\equiv p^{z*}_t/p^*_t$) is the relative price of foreign credit goods; note that $q_t = c^2/q^*_t$. The only difference between (4) and (4*) is the tax structure. There is no black economy in Germany. The German government levies a tax, τ^*_t, on all German labor income.

In these household constraints, we have assumed that the cash in advance

constraints were binding in the previous period; that is,

$$(5)\quad m_t = p_t x_t \qquad \text{and} \qquad m_t^* = p_t^* x_t^*.$$

If R_t and R_t^* are greater than one, then money is a dominated asset, and the constraints will indeed be binding. In one of the equilibria we derive, R_t^* is equal to one, and German investors are indifferent between holding money and bonds; in this case, we assume (without loss of generality) that (5) still holds and savings go into bonds.

Households maximize utility subject to budget constraints. Their first order conditions are

$$(6)\quad \frac{\partial u/\partial y_t}{\partial u/\partial x_t} = R_t^{-1} + \theta_t, \qquad \frac{\partial u/\partial z_t}{\partial u/\partial x_t} = q_t(R_t^{-1} + \theta_t), \qquad \frac{\partial u/\partial x_t}{\partial u/\partial x_{t+1}}(1+\delta) = R_t\left[\frac{p_t}{p_{t+1}}\right],$$

$$\frac{\partial u/\partial y_t^*}{\partial u/\partial x_t^*} = R_t^{*-1}, \qquad \frac{\partial u/\partial z_t^*}{\partial u/\partial x_t^*} = q_t^* R_t^{*-1}, \qquad \frac{\partial u/\partial x_t^*}{\partial u/\partial x_{t+1}^*}(1+\delta) = R_t^*\left[\frac{p^*_t}{p^*_{t+1}}\right].$$

Marginal rates of substitution are set equal to relative prices.

Governments also face budget constraints in the financial exchange:

$$(7)\quad R_{t-1}(b_{It-1} + b^*_{It-1}) + p_{t-1}(g - T) \le b^*_{It} + b_{It} + m_t - m_{t-1} + \theta_t p_t(y_t + q_t z_t)$$

$$R^*_{t-1}(b_{Gt-1} + b^*_{Gt-1}) + p^*_{t-1}(g^* + q^*_{t-1}T) \le b_{Gt} + b^*_{Gt} + m^*_t - m^*_{t-1} + \tau^*_t p^*_t n^*_t.$$

On the left hand side of each of these constraints, the first term is principal

plus interest on the debt, while the second is a settling of last period's credit transactions. T is a transfer from the German government to the Italian government; we will consider combined EC policies that make such transfers possible. Governments are credit customers; g and g* are bought on credit. We also assume that intergovernmental transfers are credits that are settled in the next financial exchange.[8] On the right hand side of the constraints, the first terms are new debt issue, and the last is tax proceeds.

We let h_t and h_t^* be the growth rates of the two monies, defined in a rather peculiar way,

$$(8)\quad h_t \equiv (m_t - m_{t-1})/m_t \qquad \text{and} \qquad h_t^* \equiv (m_t^* - m_{t-1}^*)/m_t^*.$$

Seignorage collections can be expressed as

$$(9)\quad m_t - m_{t-1} = h_t m_t \qquad \text{and} \qquad m_t^* - m_{t-1}^* = h_t^* m_t^*;$$

so, h_t and h_t^* may be viewed as seignorage tax rates.

In this paper, we only consider stationary equilibria.[9] A number of results for stationary equilibria follow immediately from the arbitrage conditions, (3), the cash in advance constraints, (5), and the first order conditions, (6):

$$(10)\quad R_t^{-1}(1+\delta) = m_t/m_{t+1} = 1 - h_{t+1}, \qquad R_t^{*-1}(1+\delta) = m_t^*/m_{t+1}^* = 1 - h_{t+1}^*,$$

$$h_t = \pi_t \equiv (p_t - p_{t-1})/p_t, \qquad h_t^* = \pi_t^* \equiv (p_t^* - p_{t-1}^*)/p_t^*,$$

$$1 - \hat{e}_{t+1} = (1 - \pi_t)/(1 - \pi_t^*), \qquad \hat{e}_t \equiv (e_t - e_{t-1})/e_t.$$

These results are standard. Inflation rates are equal to money growth rates, which in a stationary equilibrium can also be viewed as seignorage tax rates. The rate of depreciation is approximately equal to the difference in inflation rates, and nominal interest rates increase with money growth rates.

In a stationary equilibrium, the first order conditions become

$$(11)\quad \frac{\partial u/\partial y}{\partial u/\partial x} = \frac{1 - h}{1 + \delta} + \theta, \qquad \frac{\partial u/\partial z}{\partial u/\partial x} = q\left[\frac{1 - h}{1 + \delta} + \theta\right],$$

$$\frac{\partial u/\partial y^*}{\partial u/\partial x^*} = \frac{1 - h^*}{1 + \delta} \quad \text{and} \quad \frac{\partial u/\partial z^*}{\partial u/\partial x^*} = q^*\left[\frac{1 - h^*}{1 + \delta}\right].$$

The household budget constraints become

$$(12)\quad x + \theta(y + qz) = (1 - h)(n - y - qz)$$

$$x^* + \tau^* n^* = (1 - h^*)(n^* - y^* - q^* z^*),$$

and the government budget constraints become[10]

$$(13)\quad (1 - h)(g - T) = \theta(y + qz) + hx \quad \text{and} \quad (1 - h^*)(g^* + q^* T) = \tau^* n^* + h^* x^*.$$

In addition, there is no borrowing or lending, so trade balances must equal the intergovernmental transfer. For example, the Italian trade deficit, in units of the Italian cash good, is equal to[11]

(14) $qz - cz^* = T$.

The EC policymaker's constraint is found by aggregating the Italian and German government budget constraints:

(15) $g + g^*/q^* = [\theta(y + qz) + hx]/(1 - h) + (\tau^* n^* + h^* x^*)/q^*(1 - h^*)$.

T, the intergovernmental transfer, is now implicit. Finally, it should be noted that not all of these budget constraints are independent; using the resource constraints and the trade deficit equation, the household budget constraints, (12), imply the EC policymaker's constraint, (15).

Summarizing, a stationary equilibrium in the two currency version of the model is defined by the two resource constraints, (2), the four first order conditions, (11), and the two household budget constraints, (12). If an equilibrium exists, the variables x, y, z, x*, y*, z*, q, and the tax rates h, θ, h*, τ* must satisfy these eight equations.

Three modifications must be made in the model if Europe adopts a single currency, the ECU. First, the resource costs associated with multiple currencies are eliminated, so c = 1. Second, a single quantity equation, denominated in ECU's and reflecting both countries' cash in advance constraints, is used to calculate inflation. And finally, we have to explain what is done with the seignorage proceeds.

We now go through the model, equation by equation, explaining the required modifications. The utility functions, (1), are unchanged. The c's drop out of the resource constraints, (2). The c's and the e's drop out of (3), and q_t =

$1/q_t^*$; p_t is the ECU price of the Italian good and p_t^* is the ECU price of the German good. The e's drop out of the household budget constraints, (4). The first order conditions, (6), are the same, with of course R_t equal to R_t^*.

The cash in advance constraints, (5), reduce to one equation,

$$(16)\quad m_t = p_t x_t + p_t^* x_t^* = p_t(x_t + q_t x_t^*) = p_t^*(x_t/q_t + x_t^*),$$

where m_t is the supply of ECU's.

In a stationary equilibrium,

$$(17)\quad \pi = \pi^* = H,$$

where H is the growth rate of ECU's. The household first order conditions, (11), become

$$(18)\quad \frac{\partial u/\partial y}{\partial u/\partial x} = \frac{1 - H}{1 + \delta} + \theta, \qquad \frac{\partial u/\partial z}{\partial u/\partial y} = q\left[\frac{1 - H}{1 + \delta} + \theta\right],$$

$$\frac{\partial u/\partial y^*}{\partial u/\partial x^*} = \frac{1 - H}{1 + \delta} \quad \text{and} \quad \frac{\partial u/\partial z^*}{\partial u/\partial y^*} = q^*\left[\frac{1 - H}{1 + \delta}\right].$$

The household budget constraints, (12), become

$$(19)\quad x + \theta(y + qz) = (1 - H)(n - y - qz)$$

$$x^* + \tau^* n^* = (1 - H)(n^* - y^* - z^*/q),$$

and the EC policymaker's constraint, (15), is replaced by

$$(20)\quad (1 - H)(g + qg^*) = \theta(y + qz) + q\tau^* n^* + H(x + qx^*),$$

Once again, the policymaker's budget constraint is redundant; using the resource constraints, it can be derived from the household budget constraints.

Summarizing, a stationary equilibrium in the single currency version of the model is defined by the two resource constraints, (2), the four first order conditions, (18), and the two budget constraints, (19). If an equilibrium exists, the variables x, y, z, x*, y*, z*, q, and the tax rates H, θ, and τ* must satisfy these eight equations.

II. The Optimal Currency Area Problem

The levels of government spending (g and g*) are fixed; the only question is how to finance them. The seignorage tax and Italy's tax on credit goods are distortionary. Germany's income tax would have been distortionary if we had modeled a labor-leisure decision. If the EC keeps the two currencies, then there are four tax rates (h, h*, θ and τ*) to be set. Having four separate taxes helps in smoothing the tax distortions, but the multiplicity of currencies imposes extra costs on producers who sell abroad. If the EC adopts a single currency, then the extra costs disappear, but there are only three taxes (H, θ, and τ*) available for tax smoothing. The EC will be an optimal currency area if the valuation and currency conversion costs are more important than tax smoothing.

To be more precise, we assume that the EC policymaker chooses the number of currencies and the rates of the available taxes to maximize a weighted sum of

the utilities of Italian and German households. First, we calculate the best that can be done if two currencies are retained; that is, we solve the problem

(21) $\max W \equiv wU + (1 - w)U^*$
$\{x,y,z,x^*,y^*,z^*,q,h,h^*,\theta,\tau^*\}$
subject to the conditions that define equilibrium
in the two currency version of the model.

Then, we calculate the best that can be done if a single currency is adopted; that is, we solve the problem

(22) $\max W \equiv wU + (1 - w)U^*$
$\{x,y,z,x^*,y^*,z^*,q,H,\theta,\tau^*\}$
subject to the conditions that define equilibrium
in the one currency version of the model.

Finally, we compare the results to determine the conditions under which the EC is an optimal currency area.

III. Tax Smoothing with Two Currencies

For simplicity, we will now let n equal n* and g equal g*. The Italian black market is the only asymmetry between the two countries. Proposition 1 gives the best that can be done if the two currencies are retained:

Proposition 1: The solution to problem (21) (with $w = .5$) is defined by

$$\frac{\partial u/\partial y}{\partial u/\partial x} = \frac{\partial u/\partial y^*}{\partial u/\partial x^*} = 1, \quad \frac{\partial u/\partial z^*}{\partial u/\partial x} = \frac{\partial u/\partial z}{\partial u/\partial x^*} = c, \quad h = -\delta + \theta(1 + \delta), \quad h^* = -\delta,$$

the resource constraints, and the household budget constraints. If we let $u(x,y,z) = \ln x + \ln y + \ln z$, then we obtain the solution:

$$x = y = x^* = y^* = (n - g)/3, \quad z = z^* = (n - g)/3c,$$

$$\theta = \frac{(1 + \delta)g + (1/3)\delta(n - g)}{(1 + \delta)g + (1/3)(\delta + 3)(n - g)}, \qquad \tau^* = \frac{\delta}{3} + \left[1 + \frac{2\delta}{3}\right]\left[\frac{g}{n}\right]$$

$$h = -\delta + \theta(1 + \delta), \quad h^* = -\delta \quad \text{and} \quad U = U^* = 3\ln\left(\frac{n - g}{3}\right) - \ln(c).$$

Proposition 1 can be verified directly, by actually doing the maximization. This is a rather messy exercise. Here, we give a heuristic argument that we think sheds more light on the solution. (An appendix with a formal proof of Proposition 1 is available upon request.)

An efficient outcome for the EC would solve the planner's problem:

(23) $\max_{\{x,y,z,x^*,y^*,z^*\}} W = .5U + .5U^*$
subject to the resource constraints, (2).

An economic planner is a hypothetical dictator who, unlike the real EC policymaker, can simply allocate labor and consumption without going through markets (or worrying about cash in advance constraints). We want to show that the allocation specified in Proposition 1 is the solution to the planner's problem, and that it can be achieved by the EC policymaker with an appropriate choice of tax rates.

In an efficient solution, marginal rates of substitution in consumption must equal marginal rates of transformation in production, and if the efficient solution is to be supported by a market economy, after tax relative prices must reflect these optimal tradeoffs. There are two margins to consider: the margin between cash goods and home credit goods, and the margin between cash goods and

credit goods sold to foreigners.

First, consider the margin between cash goods and home credit goods. Since one unit of labor will produce either a cash good or a home credit good, the marginal rate of substitution between these goods must equal one. That is what is asserted in the first set of equations in Proposition 1.

The tax rates that achieve this relative price can be deduced from the first order conditions (6) or (11). R*, the gross rate of return on German bonds, must be equal to one to avoid distortions between the German cash and credit goods; a consumer has to hold cash instead of bonds to buy a cash good, but this causes no distortion if money and bonds bring the same return. To make R* equal one, the German seignorage tax must be set in accordance with Friedman's rule; that is, h* must be equal to $-\delta$, the German rate of time preference. In Italy, the story is a little more complicated. The tax on credit goods can also cause a distortion between cash and credit goods; θ and h must be set so that

$$(24) \quad R^{-1} + \theta = \frac{1 - h}{1 + \delta} + \theta = 1.$$

In Italy, the seignorage tax on cash goods must balance the sales tax on credit goods, so that the relative price is unaffected.

Next, consider the margin between cash goods and credit goods sold to foreigners. c units of labor must be expended on a credit good sold abroad; so, the marginal rate of substitution (in the planner's welfare function) between cash goods and credit goods consumed abroad must equal c. That is what is asserted by the second set of equations in Proposition 1 (when $w = .5$).

Of course, the taxes must also produce enough revenue to finance g and g*;

the taxes must be consistent with the budget constraints. As explained in section I, we have taken the household budget constraints, (12), to be the independent constraints. However, substituting the resource constraints, (2), into the household constraints, and using (14), we recover the individual government budget constraints, (13). Moreover, there is no intergovernmental transfer in this solution;[12] so, taxes must satisfy the individual government constraints with T equal to zero. Setting x, y, z, x*, y*, z*, q and q* equal to their equilibrium values, and recalling (23) and the requirement that h* be equal to $-\delta$, we obtain the tax rates specified in Proposition 1.

In summary, Proposition 1 asserts that the EC policymaker has enough tax instruments to achieve an efficient outcome. Some of the taxes are distortionary, but with enough taxes, the distortions can be balanced to achieve efficient market prices.

Optimal tax smoothing requires different rates of inflation in Germany and Italy. In Germany, the optimal inflation rate is negative and equal to minus the rate of time preference. In Italy, the optimal inflation rate depends on the amount of government spending. It is negative when $g = 0$, but rises with g, and becomes positive for a large enough g. The Italian inflation rate may thus be either positive or negative: however, it is always greater than the German inflation rate.

Since Italian inflation must be greater than German inflation, this solution requires a continuous depreciation of the lira. From (10), $\hat{e} \approx \pi - \pi^* = h - h^* = (1 + \delta)\theta$. Any attempt to limit this depreciation would be counterproductive. Tax distortions would be introduced, and welfare would be lower in one or both countries.

IV. When is the EC an Optimal Currency Area?

If the EC were to rule out depreciations altogether, or equivalently if the EC were to adopt a single currency, the ECU, then valuation costs and currency conversion costs would be mitigated or even eliminated. In our model, these costs are eliminated, and c reverts to unity. However, with only one currency, there would be only one inflation rate, and one less tax rate for the EC policymaker to set. It turns out that there are too few taxes to eliminate the tax distortions entirely in the ECU version of the model. However, the costs associated with multiple currencies may make the EC an optimal currency area, even though tax distortions are introduced.

The solution to problem (22) gives the best that the EC policymaker can do if the ECU is adopted. In this solution, tax distortions are smoothed optimally, but they cannot be eliminated. Thus, the solution to problem (22) is more complicated than the solution to problem (21). We have not been able to say much about the solution in general, so we computed numerical solutions for particular parameter values. In the simulations reported in Table 3, we used the log linear utility described in Proposition 1; we set $\delta = .05$ and $n\ (= n^*) = 1$, and then we let $g\ (= g^*)$ vary between 0 and .2. In each case, we chose the weights in the welfare function so that Italian and German utilities would come out equal in the end, but the weights were always very close to one half.[13]

The inflation tax is the same in both countries. In the absence of any offsetting tax, it distorts the relative price of cash and credit goods, raising the price of cash goods above one when inflation is greater than $-\delta$. In Italy, the sales tax on credit goods, goes the other way, raising the price of credit goods. In the simulations, we see that Italy always consumes more cash goods than Germany, and less credit goods. When g is increased, and the

tax distortions become bigger, these asymmetries in consumption patterns grow. Consumption of the foreign credit good always comes out somewhere in between; the relative price of the foreign credit good also moves to smooth distortions.

The utilities of Italian and German households fall as g is increased, since there is less output for the private sector to share when government consumes more, and tax distortions are bigger when there is more spending to be financed. On the other hand, we also know (from Proposition 1) that the utilities decrease in the optimal two currency solution as valuation and currency conversion costs are increased. In the last column in Table 3, we report the critical values for these costs, the smallest values of c for which Italian and German utilities are bigger in the ECU solution than in the two currency solution. The critical values increase as g is increased. Higher levels of government spending require more revenue, and higher tax rates imply bigger distortions; tax smoothing is more important at high levels of government spending. Our basic result is summarized in Proposition 2.

Proposition 2: If government spending is high in the EC, then separate currencies should be maintained. If government spending is low, then the EC may be an optimal currency area.

The only surprising result in Table 3 may be the low numbers obtained for the critical values of c. Even if the government consumes as much as twenty percent of output, valuation and currency conversion costs of less that two tenths of one percent of the cost of producing an exported good make the EC an optimal currency area. Thus we have:

Proposition 3: Very moderate valuation and currency conversion costs can make the EC an optimal currency area.

V. Limitations and Suggestions for Future Research

Throughout this paper, we have assumed that the Italian black economy is a cash good, subject to a lira denominated cash in advance constraint. In section III, this allowed the EC policymaker to tax the black market separately, using the Italian inflation tax. Alan Stockman has pointed out that there is an obvious incentive here for black market participants to switch to marks, which are subject to a lower inflation tax; this possibility is simply ruled out by the cash in advance constraints in our model. It would therefore be interesting to replace our cash in advance constraints with a restriction that allowed currency substitution. Would Stockman's concern constitute an argument for currency controls? We do not know.

Throughout this paper, we have also assumed that policymakers can precommit to monetary policies that may be time inconsistent. (The policies described in section III do happen to be time consistent, since there are no distortions in the equilibrium that results; this would not be the case if, say, a labor-leisure decision were added.) We noted in the introduction that the EMS is sometimes justified on the grounds of credibility; Italy is thought to be able to solve its precommitment problem by tying the lira to the mark.[14] It would therefore be interesting to drop our assumption about precommitment and investigate time consistent solutions.[15] We speculate that Italy would once again have the higher inflation rate. Italy may wish tie the lira to the mark (if that is a viable option), even if it interferes with optimal tax smoothing. In other words, credibility may have to be weighed along with the valuation and currency conversion costs when defining an optimal currency area.

FOOTNOTES

1. Genberg (1988) provides an excellent discussion of this literature and relates it to earlier work; however, he focuses almost exclusively on small countries. Canzoneri and Gray (1985) and Canzoneri and Henderson (1988) extend the discussion to large countries, using a game theoretic approach.

2. Here, we are following a research agenda suggested by Lucas (1986). Indeed, a macroeconomic literature on international tax policy is already developing; see Kehoe (1987) and Frenkel and Razin (1988).
Mankiw (1987) reports some empirical evidence in support of the hypothesis that US inflation has been used for intertemporal tax smoothing.

3. Some have tried to measure the effects of exchange rate volatility on trade flows; see Bailey and Tavlas' (1988) recent summary of this literature. Few have found these effects significant. However, exchange rate volatility would not seem to be a good proxy for the concerns Mundell and others had in mind.

4. Of course, a serious analysis of the EC would also have to include the stabilization and credibility factors.

5. This way of modeling black markets was suggested to us by Paul Wood in the context of Latin American countries. Barro (1987) has also noted that the inflation tax may be the only way of taxing the black economy.

6. See Lucas (1987) or Lucas and Stokey (1987) and the references therein for a more detailed description of the framework outlined in this paragraph. We have extended their structure to a two country setting.

7. Here we are applying Helpman and Razin' (1984) "buyer's system" to the invoicing of credit goods. Some restriction on the use of currencies is required if exchange rates are to be determinant; this is a reflection of the fact that there is no deep theory of currency substitution embodied in the cash in advance paradigm.

8. More precisely, T is in units of the Italian cash good; so, the mark value of the credit for last period's transfer in the current financial exchange is $p_{t-1}T/e_t$. Governments incur the same valuation and currency conversion costs as the private sector; so, the total cost of the transfer is $cp_{t-1}T/e_t$ in marks or $c(p_{t-1}T/e_tp^*_{t-1})(p^*_{t-1}/p^*_t) = q^*_{t-1}(p^*_{t-1}/p^*_t)$ in units of the German cash good.

9. Given our assumptions, there is no reason to consider nonstationary solutions. Government spending is constant over time; so there is no need for intertemporal tax smoothing. There would be issues of time consistency with the monetary policies we consider, but we have assumed that policymakers are precommitted to cooperative policies.

10. If governments were cash customers, instead of credit customers, the budget constraints would be

$$g = \theta(y + qz) + h(x + g) \quad \text{and} \quad g^* = r^*n^* + h^*(x^* + g^*),$$

which are equivalent to (13).

Some governments try to increase the base for their seignorage tax by making the private sector use domestic currency for government transactions. In the present framework, such efforts are pointless. If g is a cash good, the seignorage revenue goes up by hg, but if g is bought on credit, payments are inflated away by a factor $\pi g - hg$.

11. To verify (14), use the Italian government's budget constraint to eliminate $\theta(y + qz)$ in the Italian household's budget constraint, and subtract the result from the Italian resource constraint. Equivalent operations with the German constraints give the German trade surplus, $cz - q^*z^* = q^*T$, which is equal to the Italian deficit since $q = c^2/q^*$.

12. (14) implies $T = 0$, since $z = z^*$ and since $q = c$.

13. For $g = 0$, w was .4995; for $g = .1$, w was .496; for $g = .2$, w was .493.

14. Canzoneri and Henderson (1988) question whether a credibility problem can be so easily solved: why is an announcement about an exchange rate policy more binding than an announcement about a money supply policy?

15. To do so, we would have to introduce a cost to actual (as opposed to anticipated) inflation; see Grossman (1988) or Obstfeld (1988).

REFERENCES

Bailey, Martin and George Tavlas, "Trade and Investment Performance Under Floating Exchange Rates: The U.S. Experience", IMF working paper, May, 1988.

Barro, Robert "Interest-rate Smoothing", University of Rochester, 1987.

Barro, Robert and David Gordon, "Rules, Discretion and Reputation in a Model of Monetary Policy", Journal of Monetary Economics, Vol. 12, p. 101-121.

Canzoneri, Matthew and Jo Anna Gray, "Monetary Policy Games and the Consequences of Non-cooperative Behavior", International Economic Review, Vol. 26, No. 3, October, 1985, p. 547-563.

Canzoneri, Matthew and Dale Henderson, "Is Sovereign Policymaking Bad?", Carnegie-Rochester Conference Series on Public Policy, 28, 1988, p. 93-140.

Contini, Bruno "The Second Economy of Italy" in Vito Tanzi, ed. The Underground Economy in the United States and Abroad, Lexington Books, Lexington, 1982.

de Grazia, Raffaele Clandestine Employment, International Labor Organization, Geneva, 1984.

Fischer, Stanley "Seigniorage and the Case for a National Money", Journal of Political Economy, Vol. 90, No. 21, 1982, p. 295-313.

Frenkel, Jacob and Assaf Razin, "Exchange-rate Management Viewed as Tax Policies", NBER Working Paper No. 2653, July, 1988.

Genberg, Hans "Exchange Rate Management and Macroeconomic Policy: a National Perspective", The Graduate Institute of International Studies, July 1988.

Grossman, Herschel "Inflation and Reputation with Generic Policy Preferences", unpublished manuscript, revised September, 1988.

Helpman, Elhanan and Assaf Razin, "The Role of Saving and Investment in Exchange Rate Determination under Alternative Monetary Mechanisms", Journal of Monetary Economics, 13, 1984, p. 307-325.

Kehoe, Patrick "Policy Cooperation Among Benevolent Governments May Be Undesirable", FR Bank of Minneapolis Working Paper No. 373, October, 1987.

Langefeldt, Enno "Is a Growing Unobserved Sector Undermining Monetary Policy in the Federal Republic of Germany?", in Gaertner, Wulf and Alois Wenig eds. The Economics of the Shadow Economy, Proceedings of the Conference on the Economics of the Shadow Economy, University of Bielefeld, October 1983.

Lucas, Robert "Principles of Fiscal and Monetary Policy", Journal of Monetary Economics, 17, 1987, p. 117-134.

Lucas, Robert and Nancy Stokey, "Money and Interest in a Cash-In-Advance Economy", Econometrica, Vol. 55, No. 3, May, 1987, p. 491-513.

Table 3: The Single Currency Solution

	allocation vectors	taxes	utilities	critical value of c
g = o	x = .335 x* = .331 y = .332 y* = .335 z = .334 z* = .334	H = -.039 τ* = .011 θ = .023	U = U* = -3.296	c = 1.0001
g = .1	x = .309 x* = .285 y = .289 y* = .314 z = .301 z* = .301	H = .045 τ* = .071 θ = .161	U = U* = -3.614	c = 1.0018
g = .2	x = .283 x* = .240 y = .248 y* = .291 z = .268 z* = .269	H = .131 τ* = .123 θ = .312	U = U* = -3.972	c = 1.0068

Mankiw, N. Gregory "The Optimal Collection of Seigniorage: Theory and Evidence", Journal of Monetary Economics, 20, 1987, p. 327-341.

Mundell, Robert "A Theory of Optimal Currency Areas", American Economic Review, September, 1961, p. 657-665.

Obstfeld, Maurice "Dynamic Seignorage Theory: An Exploration", unpublished manuscript, July, 1988.

Poole, William "Optimal Choice of Monetary Policy Instruments in a Simple Stochastic Macro Model", Quarterly Journal of Economics, 84, p. 197-216.

Table 1: The Importance of Seignorage*

Country:	Seignorage as a percent of total government revenue: Average 1973 - 1978	Inflation: Average 1973 - 1978
Italy	16.0	16.4
Germany	4.8	4.7
France	1.0	10.7
United Kingdom	2.8	16.1
Spain	15.6	18.3
Greece	13.5	15.5
Austria	4.7	6.9
Japan	12.9	11.3
United States	2.7	8.0

*Source: Fischer (1982), Table A1

Table 2: The Importance of the Black Economy

Source:	Percent of GNP in Italy	Percent of GNP in Germany
Kent Matthews*	15 to 20	7 to 10
de Grazia (1984)	20 to 25	2
Contini (1982)	14 to 20	---
Langfeldt (1983)	---	5 to 10

*Matthew's estimates, based on his reading of a number of studies, were given to us in private conversation.