NBER WORKING PAPER SERIES

ESTABLISHING A MONETARY UNION

Russell Cooper
Hubert Kempf

Working Paper 6791
http://www.nber.org/papers/w6791

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
November 1998

The authors thank Dave Backus, Roberto Chang, Robert Cumby, Simon Gilchrist, John Leahy, Jorge Padilla, Richard Portes, Helene Rey, Assaf Razin, Andrew Rose, Neil Wallace, and seminar participants at the Aiyagari Memorial Conference in Tel Aviv, Boston University, CEMFI, the Econometric Society 1998 Summer Meeting, NBER 1998 Summer Meeting of the IFM group, the Universita di Bologna and the Université Paris I for helpful comments and suggestions. Cooper gratefully acknowledges support from the NSF and the CNRS for its support during his Fall 1997 visit to Université Paris I. The views expressed here are those of the author and do not reflect those of the National Bureau of Economic Research.

Establishing a Monetary Union
Russell Cooper and Hubert Kempf
NBER Working Paper No. 6791
November 1998

ABSTRACT

This paper explores the gains to monetary union. We consider a two-country overlapping generations model. Agents work when young and have random tastes over the composition (domestic vs. foreign goods) of old age consumption. In equilibrium, governments require that local currency be used for transactions as a means of creating a base for seignorage. Thus agents hold multiple currencies to deal with uncertainty in their optimal consumption bundles. We argue that this equilibrium is Pareto dominated by a monetary union, in which there is a single currency and a strong central bank that optimally chooses zero inflation. As suggested by the European Commission's 1990 report, monetary union reduces the inefficiencies created by multiple currencies and leads to price stability. Finally, we argue this Pareto superior outcome cannot be achieved without cooperation of the two governments.

Russell Cooper
Department of Economics
270 Bay State Road
Boston, MA 02215
and NBER
rcooper@acs.bu.edu

Hubert Kempf
Université Paris-I Panthéon-Sorbone
106 boulevard de l'Hopital
F-75013 Paris, France

1 Introduction

This paper explores the gains to monetary union. While the adoption of a common currency will soon be a reality for much of Western Europe, understanding the motivation for a monetary union and designing optimal monetary and fiscal arrangments within such a union remains an open challenge to economists.

The relatively informal debate on monetary union has identified a number of potential gains. Following the European Commission's 1990 report on a common currency in Europe (Emerson et al. [1992]) it is convenient to focus on two types of benefits: efficiency and stability.

Within the first category, the European Commission, as well as numerous other economists, emphasize the savings of transactions costs under a common currency system.[1] The Commission's report estimates these gains at nearly 0.5% of European Community GDP. Apart from these direct savings, it is also argued that there are further gains from a more efficient price mechanism, increased competition and larger, more integrated markets. Included in the second category is the stability of prices and output. In particular, the aims of reducing the levels of both inflation and unemployment as well as their variability are identified in the report.

One of the goals of this paper is to evaluate these arguments in favor of a monetary union within a dynamic general equilibrium structure rather than the traditional model of currency areas.[2] As noted by Wyplosz [1997], from the perspective of the traditional Mundell-McKinnon-Kenen model of optimum currency areas, "... the case for Europe as an optimal currency area is lukewarm at best." Our model departs from the traditional approach by allowing private agents and their governments to act optimally. Further, we study an overlapping generations model in which all markets clear as prices are fully flexible. Despite this discipline, we do find that there are some

[1] See, for example, the discussion in Feldstein [1997].

[2] As emphasized in Krugman [1995], while the issue of optimal currency areas is central to international monetary economics, we suffer from ".. almost total ignorance about the crucial microeconomics trade-offs involved in the formation of monetary areas."

welfare gains to monetary union which, given the structure of our model, we are able to completely characterize.

The model we study in this paper indicates two key gains to monetary union which parallel the informal arguments advanced by the European Commission. First, as suggested by the commission, the adoption of a single currency reduces the frictions associated with the flow of goods across countries. In our abstract formulation, these gains arise from the inability of agents to costlessly respond to specific changes in their tastes for goods in a multi-currency world (studied in Section II of the paper). The adoption of a common currency thus facilitates the response of agents to these individual shocks and, in equilibrium, leads to a more efficient allocation of goods. We view this result as representing the welfare gains associated with reducing trade frictions created by the presence of multiple currencies.[3]

Second, our model highlights the price stability benefit of monetary union from the centralization of monetary policy. In a world with multiple independent currencies and local currency cash-in-advance constraints, governments maximize national welfare by creating excessive inflation. While distortionary, inflation is desired as it taxes the money holdings of foreign agents and thus benefits home citizens.[4] In contrast, a central bank under a monetary union will internalize the interdependence between countries and optimally choose a lower inflation rate.

While this argument is cast here through an abstract seignorage game between governments, there is a very general and powerful point underlying the analysis: the gains to centralization arise from the internalization of the external effects of national policies. This theme appears often in the literatures on fiscal federalism and trade policies as well.[5] With reference to monetary policy, the European Commission report (Emerson et al. [1992, pg. 114]) notes, ".. the adoption of a common monetary policy handled by

[3]As discussed in more detail below, our model does not have explicit transactions costs. Instead the inefficiencies appear as an ex post misallocation of consumption goods.

[4]This point has already been made by Canzoneri [1989] in a slightly different model. The inflation tax model is used here as a metaphor for a host of policies which a government can use to influence a country's terms of trade. See also the discussion in Aizenman [1992]. In Section IV we argue that these policies (requiring local currency for exchange and inflating) arise in the equilibrium of a policy game between governments.

[5]Inman and Rubenfield [1997] provide a recent discussion of these issues. Dixit [1987] discusses this point in the context of trade policies as devices for profit shifting.

EuroFed will remove the possibility of beggar-thy-neighbour monetary and exchange rate policies."

Overall, monetary union eliminates both allocative inefficiencies and distortions from inflation. Because governments are unable to influence terms of trade through their control of the stock of local currency, agents are no longer taxed by the inflation policy of other governments. Furthermore, agents can meet their random liquidity needs out of their holdings of the single currency. Thus, as in the European Commission's report, monetary union increases efficiency by eliminating distortionary inflation and providing a market structure which supports the ex post efficient allocation of goods.

We are then naturally led to the second theme of this paper. Having identified gains to monetary union within our model, establishing a monetary union should be a relatively easy matter. However, we show that it is actually impossible for countries to reap the gains to monetary union without entering into a cooperative agreement for the construction of a monetary union.

To develop this theme, Section IV of the paper studies a game in which government choose both their monetary institutions (whether or not to impose local currency requirements) and their inflation rates. We first argue that the allocation under a monetary union is identical to that achieved in a world economy with local currencies as long as governments do not impose a local currency requirement and do not inflate. However, we show that, acting independently, governments will choose to deviate from the monetary union outcome by imposing local currency requirements and inflating. That is, the monetary union allocation is not a Nash equilibrium of our game.

We provide conditions such that the Nash equilibrium entails the imposition of local currency requirements and positive inflation. In this way, the paper also contributes to the theoretical international macroeconomics literature by providing an explanation for local currency cash-in-advance constraints.

In fact, the game between governments is one of a prisoners dilemma with the monetary union outcome arising from the "cooperation" of both countries. From this perspective, monetary union is viewed as a cooperative outcome requiring joint action for its construction and its stability.

2 World Economy with Local Currencies

We consider an overlapping generations structure in which all agents live for two periods.[6] The horizon is infinite with time indexed by $t = 1, 2, \ldots$. Further, there are two islands, "home" and "foreign", which are identical. There is trade across these islands (explained in detail below) but labor is immobile. Each island's government issues its local currency and imposes that local good is traded through the use of this currency. This corresponds to the imposition by each government of a local currency cash-in-advance constraint.

Before proceeding, it is useful to relate the key components of our model to the underlying discussion of the gains to monetary union. While the model could certainly be extended to capture production using imported inputs, nominal assets other than fiat money and so forth, as it currently stands the model does include the main ingredients needed for an analysis of monetary union. In particular, the model emphasizes: (i) trade and financial interdependence between countries, (ii) the existence of nominal assets and (iii) the presence of trading frictions that could be alleviated through the creation of a common currency.

The analysis will first focus on the optimization problem of a representative agent on the home island. The next subsection looks at market clearing. We then characterize the monetary steady state. The main proposition of this section shows that equilibrium inflation rates are positive.

2.1 Basic Model

2.1.1 Optimization

The optimization problem of a representative, generation t home agent is given by:

$$\max_{m_t^h, m_t^f, n_t \epsilon [0,1]} E_\theta \left(\theta \ln(c_{t+1}^h) + (1-\theta) \ln(c_{t+1}^f) \right) - g(n_t) \tag{1}$$

subject to:

$$p_t n_t = m_t^h + e_t m_t^f$$

[6]Multi-country CIA models are quite prominent in the open economy macroeconomics literature. See, for example, the presentation in Obstfeld-Rogoff [1997] and the references therein. Sargent [1987, Chpt.5] also outlines such a model in detail.

$$
\begin{aligned}
c^h_{t+1} &= (m^h_t + \tau_{t+1})/p_{t+1} \\
c^f_{t+1} &= m^f_t / p^*_{t+1}.
\end{aligned}
\tag{2}
$$

In (1), the superscript h refers to the home country and f to the foreign country. Old age utility from consumption is a sum of two terms, $(\theta \ln(c^h_{t+1}) + (1-\theta)\ln(c^f_{t+1}))$, where c^j_{t+1} is the consumption of good $j = h, f$ in period $t+1$. The level of work, given by n_t, is between zero and one as each agent has a unit endowment of time. The disutility of work is represented by $g(n_t)$ which is assumed to be increasing, convex and continuously differentiable. For simplicity, we assume that output is equal to input so that the agent produces n_t units of goods from this same level of labor input. The variables p_t and p^*_t are the prices of goods h and f, denominated in Home currency and Foreign currency, respectively.

The random variable θ represents a shock to the tastes of the agent with high values of θ increasing the utility flow from the consumption of the home good. We assume that $\theta \in (0,1)$ and all agents on both islands draw from the same distribution given by $H(\theta)$. Let $\bar{\theta}$ be the mean value of this random variable. Realizations of this shock are **independent** across agents and islands. Hence this is a purely **idiosyncratic** taste shock.

The first constraint implies that the agent takes the money earned in youth and allocates it to the holdings of domestic currency (m^h_t) and foreign currency (m^f_t). Here e_t is the period t exchange rate: the amount of domestic currency per unit of foreign currency.

The second and third constraints imply that old agents take their money holdings and spend them on home and foreign goods. These constraints reflect two important aspects of our environment. First, within a period, exchange markets open **after** goods markets. Hence old agents cannot adjust their portfolio holdings before going to goods markets: this is a basic friction in our model.[7] Second, agents are required to make purchases using local currency. This is an assumption of our model at this point, though in Section IV we show that this type of constraint will arise endogenously in the game between governments. Given these constraints, old agents have no choice: they will optimally spend all of their money holdings.

[7] This is a broader view of market frictions than simply imposing a trading cost. Adding such a cost to our model would modify our analysis since some agents would, ex post, elect to pay this cost to modify their portfolio of currencies. In effect, this is similar to reducing the variability of the taste shock in our present formulation.

The process of money creation is reflected in the evolution of domestic money holdings. In particular, each young agent in generation t, regardless of his money holdings, receives a transfer of τ_{t+1} at the start of old age. This transfer is perfectly anticipated. Note that an agent does not receive transfers of foreign currency: this is the basis of the inflation tax on foreign currency holders which, as we shall see, redistributes real wealth to domestic citizens.

It is critical that θ is realized **after** the choices of employment and currency holdings. If, for example, θ was known in youth, then the portfolio choice of the young agents would reflect this variable and there would be no ex post misallocations. In our model, in contrast, because of the local currency in advance constraints, ex post consumption profiles must be financed out of ex ante portfolio choices. Given the nature of the preferences we have assumed, it is clear that agents will generally want to adjust their expenditures after the realization of the taste shock but are prevented from doing so by the local currency constraints and the assumed timing of the markets.

The first order conditions for the agent's optimization problem is summarized by two conditions:

$$\begin{aligned} E_\theta\{\frac{(1-\theta)p_t}{p_t n_t - m_t^h}\} &= g'(n_t) \\ E_\theta\{\frac{p_t n_t - m_t^h}{m_t^h + \tau_{t+1}}\} &= \frac{E(1-\theta)}{E\theta} \equiv Z. \end{aligned} \tag{3}$$

The first of these conditions relates the marginal disutility of work to the marginal utility from the consumption of the foreign good. The second condition is essentially the expenditure share condition that emerges in optimization problems with Cobb-Douglas preferences, though here the expectation of θ rather than the realization of this variable determines expenditure shares since portfolio decisions are made ex ante. Note that given the specification of utility, the future price of foreign goods is not present in these conditions. That is, labor supply and the budget shares depend on the current return to work as well as the transfer but not period $t+1$ prices.

There is of course a complementary set of first order conditions from the perspective of a representative generation t agent on the foreign island. The foreign representative agent solves the following optimization problem:

$$\max_{m_t^{*f}, m_t^{*h}, n_t^* \epsilon [0,1]} E_\theta \left(\theta \ln(c_{t+1}^{*f}) + (1-\theta) \ln(c_{t+1}^{*h}) \right) - g(n_t^*)$$

subject to:

$$p_t^* n_t^* = m_t^{*f} + m_t^{*h}/e_t$$
$$c_{t+1}^{*f} = (m_t^{*f} + \tau_{t+1}^*)/p_{t+1}^*$$

$$c_{t+1}^{*h} = m_t^{*h}/p_{t+1}$$

where c_{t+1}^{*f} is the consumption of the foreign good by foreigners and $c_{t+1}^{*h}$is their consumption of the home produced good. Likewise, m_t^{*f} represents the money demand by foreign agents of foreign (their home) currency, m_t^{*h} is the money demand by foreign agents of home currency, τ_{t+1}^* is the transfer to foreign agents and n_t^* is their labor supply.

The first order conditions are given by:

$$\begin{aligned} E_\theta\{\frac{(1-\theta)p_t^*}{p_t^* n_t^* - m_t^{*f}}\} &= g'(n_t^*) \\ E_\theta\{\frac{p_t^* n_t^* - m_t^{*f}}{m_t^{*f} + \tau_{t+1}^*}\} &= \frac{E(1-\theta)}{E\theta} \equiv Z \end{aligned} \tag{4}$$

Note too that in (4), the random variable θ impacts directly on home consumption, in a manner symmetric with (3). As we shall see, the magnitude of $\bar{\theta}$ is an important factor in the gains to monetary union.

2.1.2 Market Clearing

In each period, there are five markets that must clear: the two goods markets, the two money markets and the exchange market. The goods markets open at the start of the period. Here old agents from both islands use their local currency to purchase the goods produced by young agents. Each national money market is the flip side of these transaction: young agents sell their goods to acquire the local currency held by the old. Finally, in the exchange market, currencies are exchanged as young agents optimally set their portfolios.

On the home island, money market clearing is given by:

$$M_t = p_t n_t \ . \tag{5}$$

The left side of this expression is the exogenously given stock of fiat money in per capita (per home citizen) and the right side is the money value of output per home producer in period t.

The evolution of the stock of home money is given by

$$M_{t+1} = M_t(1+\sigma)$$

where σ is the fixed growth rate of money in the home economy. In the equilibrium analysis, this growth rate will be chosen by the government: for now it is taken as given. Since the money supply increases through lump-sum transfers, as in (2),

$$\tau_{t+1} = M_t \sigma. \tag{6}$$

The condition for exchange market equilibrium is:

$$m_t^{*h} = e_t m_t^f. \tag{7}$$

The left side of this condition is the per capita money holdings of home currency by foreigners. The right side is the value, in terms of home island units of account, of the foreign money holdings of home agents. This condition guarantees that the portfolio adjustment at the end of youth (after goods market exchange) balance so that the home currency given up by the home agents is exactly equal to the holdings of home currency by the foreign agents.

A final form of money market clearing is to check that the exogenous stocks of domestic and foreign currencies are held by someone after the close of the exchange markets. These two conditions are given by

$$M_t = m_t^h + m_t^{*h}$$

and

$$M_t^* = m_t^{*f} + m_t^f.$$

2.2 Equilibrium with Local Currency Constraints

Given the conditions for optimization by the representative agent in each country and the market clearing conditions, the goal is to characterize the steady state equilibrium with valued fiat money in **both** economies given the two exogenous rates of money growth, σ and σ^*.[8] We then turn to the determination of the equilibrium rates of inflation.

2.2.1 Steady States Given Rates of Money Creation

To characterize the equilibrium, we conjecture that agents on the home (foreign) island hold a fraction ϕ (ϕ^*) of their local currency earnings in youth in domestic currency and the remainder is used to purchase foreign currency. Thus,

$$m_t^h = \phi p_t n_t \text{ and } e_t m_t^f = (1-\phi) p_t n_t$$

for generation t agents in the home economy. There is an analogous specification for foreign agents.

Let n and n^* represent the steady state employment levels on the two islands. Then a steady state monetary equilibrium is given by (ϕ, n, ϕ^*, n^*) and a price system $(p_t, p_t^*, e_t)_{t=1}^{\infty}$ such that the conditions for individual optimization and market clearing are met.

Our approach to characterizing the steady state is to use the market clearing conditions to substitute for the relative prices in (3) and (4). This will leave us with a set of first order conditions in terms of portfolio shares and employment levels, (ϕ, n, ϕ^*, n^*). The result is summarized in the following proposition, using Z$\equiv (1-\underline{\theta}/\bar{\theta})$.

Proposition 1 : *A steady state equilibrium is characterized by the following conditions:*

$$\begin{aligned} \phi &= \frac{1-Z\sigma}{1+Z} \\ \frac{1}{1+\sigma} &= ng'(n) \end{aligned} \tag{8}$$

[8] As is customary in overlapping generations models there will also be non-monetary equilibria as well as non-stationary equilibria.

$$\phi^* = \frac{1 - Z\sigma^*}{1 + Z}$$
$$\frac{1}{1+\sigma^*} = n^* g'(n^*).$$

Proof. : Here we focus on the conditions for the home country. Those for the foreign country are completely analogous. We use the conjectured portfolio shares along with the condition relating transfers to the stock of money, (6), to find:

$$p_t n_t - m_t^h = (1-\phi)M_t \quad (9)$$
$$m_t^h + \tau_{t+1} = (\phi + \sigma)M_t \quad (10)$$

Substituting this into the second of the first-order conditions for the home country implies:

$$\frac{(1-\phi)}{\phi + \sigma} = Z$$

which yields the first of the steady state conditions after some manipulation.

Using the home market clearing condition as well as (9) in the first of the first-order conditions gives:

$$\frac{(1-\bar{\theta})}{(1-\phi)} = ng'(n).$$

Substituting for ϕ and using the definition of Z yields the second of the steady state conditions for the home country. ■

In terms of characterizing the existence of a steady state, we focus on equilibria in which fiat money is valued in both economies. That is, we look for equilibria in which citizens of both countries hold both currencies. We term these interior monetary equilibria and find:

Proposition 2 *For every ($\sigma \in (-1, 1/Z)$, $\sigma^* \in (-1, 1/Z)$), there exists an interior monetary steady state.*

Proof. : Note that both portfolio shares, ϕ and ϕ^*, are given directly from the home and foreign conditions which relate these portfolio shares to Z and the rate of domestic money creation. The bounds on these rates of money creation guarantee that both ϕ and ϕ^* lie in the interval $(0,1)$, which is necessary for an interior monetary equilibrium.

Given the rates of domestic money creation, the labor supply choices, n and n^*, are immediately determined. Note that $ng'(n)$ is monotonically increasing in n since $g(\cdot)$ is convex. ■

There are some interesting properties of the steady state. First, domestic output and employment depend on the rate of domestic money creation. In the usual manner, inflation brought about by lump-sum transfers creates a tax on domestic productive activity. Hence an increase in the rate of domestic inflation reduces employment and output. In a closed economy, domestic inflation would thus be welfare reducing.

Second, domestic output and employment do not depend on the foreign rate of money creation. In the same way, portfolio shares do not depend on foreign rates of money creation. These simplifications, of course, reflect the assumption of Cobb-Douglas preferences with the resulting implications for constant budget shares. However, as we shall see, this specification of preferences allows us to explicitly characterize the inflation game between countries as well as the gains to monetary union.

2.2.2 Determination of Equilibrium Inflation Rates

Using the equilibrium from Proposition 2, let $V(\sigma,\sigma^*)$ and $V^*(\sigma^*,\sigma)$ be the lifetime expected welfare of an agent in the home and foreign islands respectively. Formally,

$$V(\sigma,\sigma^*) = E_\theta\left(\theta\ln(c^h) + (1-\theta)\ln(c^f)\right) - g(n(\sigma))$$

and

$$V^*(\sigma^*,\sigma) = E_\theta\left(\theta\ln(c^{*f}) + (1-\theta)\ln(c^{*h})\right) - g(n^*(\sigma^*))$$

where the functions $n(\sigma)$ and $n^*(\sigma^*)$ are determined in the equilibrium established in Proposition 2. Since $g(n)$ is assumed to be continuously differentiable, $n(\sigma)$ and $n^*(\sigma^*)$ are continuously differentiable functions of the money growth rates.

The consumption levels in these expressions come from the conditions for the steady state equilibrium:

$$c^h = \frac{(\phi+\sigma)}{(1+\sigma)}n(\sigma),\; c^f = \frac{(1-\phi^*)}{(1+\sigma^*)}n^*(\sigma^*).$$

Again, there are analogous expressions for the foreign consumption levels. Note that the rate of money creation in foreign countries does effect the utility level of home agents through their equilibrium consumption levels of foreign goods. Further, in equilibrium, domestic money creation has three apparent influences: directly on the level of employment, through the transfer (the numerator of c^h) and through the rate of price inflation (the denominator of c^h).

The gains and losses from inflation are evident from these conditions. **Given** the employment levels, n and n^*, home inflation increases the state contingent consumption of home agents while foreign inflation reduces it. From the definition of c^h, in order for home consumption to increase with σ, ϕ must be less than one: i.e. not all of the domestic money supply is held by domestic citizens. In this model, this comes about because agents hold the currency of the other country in order to finance their consumption in old age. Thus, to emphasize an important point, the local currency requirement creates a demand for local currency by foreign agents and thus a basis for the inflation tax.[9] This can be seen directly from the characterization of c^h: if $\phi = 1$, then the only effect of σ would be to distort the labor supply decision.

Of course, the cost of inflation arises from the fact that it taxes the money holdings of all agents, domestic and foreign. This is a distortionary tax. Higher home inflation reduces the incentive for home agents to produce which ultimately reduces c^h and thus lifetime utility. Still, starting at zero inflation, there is an incentive for countries to increase their money supplies. This observation leads to:

Proposition 3 *The symmetric equilibrium of the game between government entails positive money growth rates:* $\sigma = \sigma^* = Z$.

Proof. : Using the conditions for steady state equilibrium given above,

$$V(\sigma,\sigma^*) = E_\theta\{\theta \ln(1/(1+Z)) + \theta \ln(n(\sigma)) + (1-\theta)\ln(\frac{(1-\phi^*)n^*(\sigma^*)}{(1+\sigma^*)})\} - g(n(\sigma)).$$

The home government maximizes this with respect to σ, taking σ^* as given. This derivative equals zero when

$$ng'(n) = \bar{\theta}.$$

[9] Stated differently, each country also has an incentive to inflate in order to reduce their own output and thus influence terms of trade.

Using the condition characterizing n in the steady state (8) along with the definition of Z implies $\sigma = Z$. A symmetric argument holds for the foreign country. ■

In fact, the equilibrium with positive inflation is a dominant strategy equilibrium. Even though the foreign rate of inflation has a (negative) effect on the welfare of home agents, it has no influence on the optimal level of domestic inflation. This simplification is again a consequence of the assumed preference structure.

3 Monetary Union

The equilibrium in which countries impose cash-in-advance constraints and, as shown in Proposition 3, create positive inflation is inefficient along two dimensions. First, ex post consumption profiles do not sufficiently reflect the taste of individual agents. From the solution of (1)-(2), consumption levels are not state contingent since monetary holdings are determined prior to the taste shock.

Second, there is positive inflation which, as we show in this section, is an undesirable outcome of the interaction between governments each attempting to reap positive gains for its citizens by money creation. While inflation is individually rational, in equilibrium, these policies lead to a welfare loss.

The point of this section is to argue that the creation of monetary union in which there is a single currency and a single central bank will lead to a welfare increase for all agents. These welfare gains come from the increased liquidity created by a single currency and by the elimination of the incentive for unilateral inflation.

3.1 Basic Model of a Monetary Union

Under a monetary union, there is a single currency and a single price system. Let M_t^{MU} represent the stock of common currency in period t, σ^{MU} the growth rate of this stock, q_t^h the period t money price of home goods and q_t^f the period t money price of foreign goods.

The optimization problem of a representation agent of generation t in the home country is given by:

$$\max_{c^h_{t+1}(\theta), c^f_{t+1}(\theta), n_t \epsilon [0,1]} E_\theta\{\theta \ln(c^h_{t+1}(\theta)) + (1-\theta)\ln(c^f_{t+1}(\theta))\} - g(n_t) \quad (11)$$

subject to:

$$c^h_{t+1}(\theta)q^h_{t+1} + c^f_{t+1}(\theta)q^f_{t+1} = q^h_t n_t + \tau^{MU}_{t+1} \equiv I_t \text{ for all } \theta \quad (12)$$

In contrast to the problem specified in the previous section, (1)-(2), this problem has a single budget constraint for each value of θ since in period $t+1$ the agent will take money earned in youth plus a transfer of τ^{MU}_{t+1} and purchase both home and foreign goods after observing the taste shock. For this preference structure, the optimal consumption profile is easy to characterize. Ex post, agents will respond to variations in tastes so that:

$$c^h_{t+1} = \theta I_t / q^h_{t+1} \text{ and } c^f_{t+1} = (1-\theta) I_t / q^f_{t+1}.$$

This is the usual optimality result for this preference structure. Given this allocation of income, agents choose labor supply to solve (11). This leads to a steady state labor supply of:

$$\frac{1}{1+\sigma^{MU}} = ng'(n). \quad (13)$$

Similar equations hold for the representative consumer in foreign country.

3.2 Equilibrium and Seignorage with Monetary Union

While there are two distinct goods in this economy, the islands are completely symmetric and agents are ex ante identical. We assume that newly created currency is distributed equally across all agents.[10] Thus, we focus on characterizing a symmetric steady state equilibrium. Denote by n^{MU} the steady state level of employment by an agent on either of the islands, q_t the period t money price of goods and c^{MU} the steady state level of consumption of either of the two goods.

[10] Clearly then an interesting extension is to study political power with regards to the creation and distribution of newly created money. See for example Casella and Feinstein [1991] ,Chang [1995]

Let $n^{MU}(\sigma^{MU})$ denote the steady state value of employment for both home and, by symmetry, foreign agents. Using this, the steady state level of utility in a monetary union can be expressed as

$$\begin{aligned} V^{MU}(\sigma^{MU}) &= E_\theta\{\theta\ln(\theta n^{MU}(\sigma^{MU})) + (1-\theta)\ln((1-\theta)n^{MU}(\sigma^{MU}))\} \\ &\quad -g(n^{MU}(\sigma^{MU})). \end{aligned}$$

The optimal monetary policy for a bank that chooses the rate of money growth to maximize the utility of a representative agent is characterized by:

Proposition 4 : *The optimal monetary policy in a monetary union is* $\sigma^{MU} = 0$.

Proof. : The monetary authority solves $max_{\sigma^{MU}} V^{MU}(\sigma^{MU})$. This leads to:

$$1 = ng'(n)$$

Using (13), this condition is met with $\sigma^{MU} = 0$. ■.

So, the central bank governing the growth of the money supply will optimally choose zero inflation and the single currency implies that agents can, ex post, optimally respond to their taste shocks. This is not a surprising result given that there are no gains to inflation in the common currency environment.

3.3 Measuring the Gains to Monetary Union

Using Proposition 3, let V^{LC} be the expected utility of an agent in the equilibrium of the world economy with local currencies given that both countries inflate at rate Z. This is given by:

$$V^{LC} = E_\theta\{\theta\ln(1/(1+Z)) + \ln(n(Z)) + (1-\theta)\ln(Z/(1+Z))\} - g(n(Z))$$

where $n(Z)$ is the steady state equilibrium level of employment given that the rate of money creation is Z.

In a similar manner, Proposition 4 implies that the lifetime utility in a monetary union (V^{MU}) is given by:

$$V^{MU} = E_\theta\{\theta\ln(\theta) + \ln(n(0)) + (1-\theta)\ln(1-\theta)\} - g(n(0))$$

where $n(0)$ is the steady state level of employment at zero inflation.

Using these expressions, let $\Delta(Z)$ be the utility gain from monetary union:

$$\Delta(Z) \equiv V^{MU} - V^{LC}(Z,Z) = \tag{14}$$

$$E_{\theta}\{\theta \ln(\frac{\theta}{\bar{\theta}}) + (1-\theta)\ln\frac{(1-\theta)}{(1-\bar{\theta})}\} + \tag{15}$$
$$[\ln(n(0)) - g(n(0))] - [\ln(n(Z)) - g(n(Z))].$$

There are two positive terms in this expression which correspond to the two types of gains from monetary union highlighted by the European Commission: increased efficiency and price stability.

The first represents the gains associated with achieving an ex post efficient allocation of goods, given the uncertainty in tastes. If there was no uncertainty, so that $\theta = \bar{\theta}$, then the first terms in $\Delta(Z)$ would be zero. Using a second-order Taylor series expansion, one can show that the first line in $\Delta(Z)$ can be written as:

$$E_{\theta}\{\theta \ln(\frac{\theta}{\bar{\theta}}) + (1-\theta)\ln\frac{(1-\theta)}{(1-\bar{\theta})}\} = \frac{1}{2}var(\theta)\left(\frac{1}{\bar{\theta}} + \frac{1}{(1-\bar{\theta})}\right) \tag{16}$$

Thus partial gains to monetary union are proportional to the variance in the taste shocks. This is quite intuitive since the change in regime to a single currency allows agents to respond to taste shocks. This gain should be positively related to the variability of tastes which, for the Cobb-Douglas preference structure, reduces to (16).

Note that the European Commission's calculation of the gains to monetary union from a reduction in trading costs looked solely at the product of trade volume and the costs associated with a variety of trading fees and exchange margins. In our abstract model, the trading frictions associated with multiple currencies are reflected in differences in ex post marginal rates of substitution between agents. If, as noted earlier, we allowed agents to adjust their portfolios ex post, then the model would produce two measures of frictions. The first would be the direct transactions costs paid by agents whose taste shocks were extreme enough to induce them to alter their portfolios. The second would arise from agents who did not pay these costs and thus retained their ex ante portfolio. In this model, the trading frictions would include both the explicit transactions costs paid by the first group and the unexploited gains to trade of the second group. Clearly, the European Commission calculation captures only the first measure of inefficiency.

The second term in $\Delta(Z)$ represents the gains to monetary union associated with the reduction in the rate of inflation from Z to 0. Since inflation is distortionary, the gain is related to the responsiveness of the labor supply decision to the rate of inflation and the magnitude of Z. A second-order Taylor series expansion of the second term in (14) implies

$$\begin{aligned} & [\ln(n(0)) - g(n(0))] - [\ln(n(Z)) - g(n(Z))] \\ \simeq\ & \frac{1}{2}\left[\frac{n(Z)-n(0)}{n(0)}\right]^2 (1+\frac{g''(n(0))n(0)}{g'(n(0))}) \end{aligned} \tag{17}$$

The first term on the right measures the gap between the level of employment in the local currency regime and that arising under monetary union due to inflation. The second term on the right reflects the curvature in the disutility of work function: the larger the curvature the larger is the loss in utility due to a given level of inflation.

For example, if we assume that $g(n) = n/k$, where k is a constant, then $n(Z) = k/(1+Z)$. This leads to the following simplification of the second term in $\Delta(Z)$:

$$[\ln(n(0)) - g(n(0))] - [\ln(n(Z)) - g(n(Z))] = k^2(1-\bar{\theta}) - \ln(\bar{\theta}).$$

So, if the economy was closed, implying $\bar{\theta} = 1$, then this term would be zero because the level of inflation would be 0. As $\bar{\theta}$ falls from 1, this term increases reflecting the difference between $n(0)$ and $n(Z)$.

4 Establishing A Monetary Union

The first goal of this paper was to provide an explicit model of the gains to monetary union. From the perspective of price stability, an important implication of Proposition 4 is that the rate of inflation in a monetary union is less than that arising in an equilibrium with multiple currencies. From Proposition 3, the inflation rate in a world economy with multiple currencies will have an inflation rate of $Z \equiv \frac{(1-\bar{\theta})}{\bar{\theta}}$ which can be quite large in an economy that is reasonably open. For example, if average budget shares for imported goods is .2, then $Z = 25\%$.[11]

Further, monetary union has the advantage of allowing agents to respond to variations in tastes. To emphasize an important point, having a single currency implies that agents can arrange their consumption bundle after realization of their individual θ.

Given these gains, we turn to a discussion of establishing a monetary union. Despite these gains highlighted in our analysis and more generally in the report of the European Commission, the creation of a monetary union between sovereign countries apparently requires a very strong international commitment. The difficulties of achieving a union are clearly exemplified by the lengthy and painful negotiations leading to the European Monetary Union. A natural question is whether it is possible to reap these gains from monetary union through a less demanding route. In other words, is cooperative action (i.e. by means of a treaty as in the European case) necessary in order to form a monetary union?

We study this question by constructing a game between governments in which the monetary regime emerges endogenously. Within this model, our answer to this question is clear: reaping the gains from monetary union does indeed require cooperation. While it is true that the allocation supported by monetary union is feasible in other, less centralized monetary systems in which countries do not impose local cash-in-advance constraints, these are not equilibrium allocations. Individual governments, representing the interests of their citizens, have an incentive to impose these constraints. So, while there are mutual gains to monetary union, individual governments have an incentive to deviate from a monetary union to pursue their own objectives.

Note that this result serves two purposes. First, it explains why monetary union requires a cooperative effort among member countries. Second, it provides an explanation of the cash-in-advance constraints that were taken as given in Section II of the paper and used extensively in the international macroeconomics literature.

To see this point formally, we consider a multi-stage game, which we term a "monetary policy game". In the first stage, governments choose their monetary regime, either imposing a local currency cash-in-advance constraint

[11]Of course, not all trades generate money demand as assumed in our model. However, there are also numerous investment flows across countries that generate money demands that are not included here. Further, countries often issue nominally denominated debt that is eventually held by foreigners. This could create another basis for the inflation tax.

(CIA) or not. If they choose not to impose a CIA, then any currency can be used for making purchases in that economy. In the second stage, governments simultaneously choose a rate of inflation for their money supply. Finally, we look at the steady state of the world economy given these policy choices.

The interaction between governments can be succinctly represented by the following normal form structure. Here the governments each choose whether to impose a CIA or not. The payoffs in each cell are then determined by the subsequent inflation policies of the government and the consequent steady state equilibrium. The discussion below develops the payoffs for each of these cells.

Foreign

		CIA	no CIA
Home	CIA	V^{LC}, V^{LC}	v^{LC}, v^{NLC}
	no CIA	v^{NLC}, v^{LC}	V^{NLC}, V^{NLC}

Note that the structure of our game assumes that governments can commit to a monetary regime. Besides simplifying the analysis, this allows us to distinguish our results from those that rest on internal commitment problems.[12] In our economy, if a government could choose the monetary transfer each period **after** agents chose their labor supply, then each government would have an incentive to inflate the money supply beyond the level calculated in Section II. Alternatively, if the government could commit to a money creation rate prior to the labor supply choice of agents, then it would choose the inflation rate of Z as characterized in Proposition 3.

In the next section we argue that in a two-currency world, if: (i) neither country imposes a CIA and (ii) neither country inflates, then the allocation is the same as that obtained under monetary union. From the perspective of our model, the merit of monetary union is not the existence of a single central bank per se but rather the elimination of both liquidity problems and inflation; just as if there were multiple currencies in all local economies acceptable for trade and the commitment of monetary authorities to zero inflation.

[12] Once again, our economy is structured so that if it was closed, there would be no incentive for inflation. Hence, the basis for inflation comes from the demand for money by foreign agents. This generates an incentive to inflate as well as a potential commitment problem vis-a-vis foreign agents.

The subsequent section argues that a configuration in which neither country imposes a CIA is **not** a Nash equilibrium. To make this argument, we characterize an equilibrium for the configuration in which the home country imposes a CIA but the foreign government does not: i.e. (v^{LC}, v^{NLC}) in the above matrix. Here the outcome is a form of "dollarization" in which the currency of the country that imposes the CIA circulates while the other currency does not. Given this equilibrium, we show that the regime in which neither country imposes a CIA is not a Nash equilibrium. Consequently, the allocation obtained through monetary union is not an equilibrium of this game.

The final subsection investigates the conditions under which both countries imposing a CIA is an equilibrium. If the variability of tastes, represented by the variance of θ, is sufficiently small, then the equilibrium entails both countries imposing CIAs. Thus the normal form game has a prisoners' dilemma structure: imposing a CIA is a dominant strategy though the outcome in which neither country imposes a CIA and neither inflates is the cooperative solution.

4.1 Relationship between Monetary Union and Laissez Faire

We begin our analysis of this game by relating the choice of monetary regime (CIA or no CIA) to a monetary union. Following Kareken and Wallace [1981], we term the regime in which neither country imposes a CIA, a "laissez faire" regime. The following proposition demonstrates that the outcome obtained in a monetary union is a feasible outcome of the game outlined above.

Proposition 5 *If neither country imposes a CIA and $\sigma = \sigma^* = 0$, then the resulting allocation is equivalent to that obtained under monetary union.*

Proof. See appendix 1 ■

Since there are no local currency constraints, consideration of this economy requires modification of the basic model presented in Section II. Consequently, the characterization of this economy and the proof of this result appear in the appendix.

However, the intuition for this result is relatively straightforward. We focus on an equilibrium in which both currencies are held. In such an equilibrium rates of return must be equal. Using this indifference, we construct an equilibrium in domestic (foreign) agents only hold their own currencies. Since neither country imposes a CIA, agents are fully able to respond to their realized taste shocks even though they could have a single currency in their portfolio. Given that neither country inflates by assumption, the labor supply decisions for both home and foreign agents are efficient as in the proof of Proposition 4. From this, we see immediately that the resulting allocation is the same as that obtained under monetary union.

To be clear, the point of this proposition is only that the monetary union allocation is a possible outcome of the interaction between countries. In this way, studying the outcome of the monetary regime game sheds light on monetary union. The proposition does not state that if neither country imposes a local CIA, then the monetary union outcome obtains. This would be a much stronger result.

4.2 Defection from a Monetary Union

The main result of this section is to show that the configuration of actions in which neither country imposes a local CIA is not an equilibrium. This result is important for two reasons. First, it indicates that monetary union will not be a equilibrium of the monetary regime game since countries have unilateral incentives to impose CIA constraints. Second, this result justifies the imposition of local CIA by governments interested in maximizing the expected utility of their own agents. While this constraint was imposed in the economy we considered in Section II, the following proposition shows how this type of constraint could arise as an equilibrium of a larger game played between governments.[13]

Formally, we find:

Proposition 6 *A regime in which neither country imposes a CIA is not a subgame perfect Nash equilibrium.*

Proof. Consider the configuration in which neither country imposes a CIA requirement and then each chooses their inflation rate. The payoff from this cannot exceed that obtained under monetary union, V^{MU}, since the outcome under monetary union selected the inflation rate that was jointly optimal. Further, from Proposition 5, we know that if neither country imposes a local

[13]This result is in the same spirit as the Bryant and Wallace [1984] argument about legal restrictions providing a basis for price discrimination by a government.

CIA requirement and each sets the rate of money creation to zero, this is the same outcome as that obtained under monetary union.

Suppose then that the home country defects from this proposed equilibrium and establishes a CIA. In this case, we consider a steady state equilibrium associated with the (CIA, no CIA) cell of the regime choice game. By following an equilibrium path resulting from the defection of the home government, we are able to argue that the conjectured equilibrium in which neither country imposes a CIA is not subgame perfect.

In the (CIA, no CIA) cell of regime game, we focus on the steady state equilibrium in which the home currency is the only one in circulation. Given this, the payoffs to a representative home agent can be written as:

$$V^{LC}(\sigma) = E_\theta\{\theta \ln(c^h(\theta,\sigma)) + (1-\theta)\ln(c^f(\theta,\sigma)) - g(n(\sigma))$$

where

$$c^h(\theta,\sigma) = \frac{\theta n(\sigma)(\phi+\sigma)}{(1+\sigma)\phi}$$

$$c^f(\theta,\sigma) = \frac{(1-\theta)n^*(\phi+\sigma)}{(1+\sigma)(1-\phi)}.$$

Here ϕ is again the share of the total money held by home agents and is given by:

$$\phi = \frac{\bar{\theta}\sigma + (1-\bar{\theta})}{\sigma + 2(1-\bar{\theta})}.$$

Further, $n(\sigma)$ solves the representative agent's first order condition in the steady state equilibrium,

$$ng'(n) = \frac{\phi}{\phi+\sigma}.$$

Finally,

$$n^* g'(n^*) = 1$$

implying that the foreign agents are optimally choosing employment as well.

Notice that these consumption levels are state contingent since agents' consumption can respond to taste shocks. This is clearly one of the gains to having a single currency.

Note that this is the same payoff level as that obtained under monetary union if the rate of home money creation was zero: i.e., $V^{LC}(0) = V^{MU}$. However, the optimal rate of money creation is not 0: the derivative of V^{LC} with respect to σ evaluated at $\sigma = 0$ is given by

$$\frac{1-\bar{\theta}}{4} + 1 - \frac{n'(0)}{n(0)}[n(0)g'(n(0)) - \bar{\theta}] \, .$$

This expression is positive since $n'(0) < 0$, $g'(n^h(0))n^h(0) = 1$ and $\bar{\theta} \in (0,1)$. Hence $V^{LC} > V^{MU}$. In fact, the optimal inflation rate when a single country imposes a local currency requirement is positive if $V^{LC}(\sigma)$ is a globally concave function. So, the proposed outcome in which neither country imposes a CIA is not an equilibrium: the best response to the other country not imposing a CIA is to impose one. ■

In the proof of this argument, we consider the defection of the home country so that it imposes a local CIA while the foreign country does not. Given this defection, what is the resulting steady state equilibrium? In the proof of the proposition we focused on a steady state equilibrium in which only the currency of the single country that imposes the CIA has value. Given this selection of an equilibrium, we show that defection from a monetary union is desirable. Hence the (no CIA, no CIA) regime is not a subgame perfect Nash equilibrium.

This selection of an equilibrium following the defection of the home government seems to be a reasonable one since the currency of the country imposing the CIA can be used in both countries while the currency of the country not imposing the CIA can only be used in its own country. Further, this selection seems compatible with the "intuitive criterion" in that a government would never defect from monetary union unless it thought that the natural outcome would be the equilibrium in which its currency had value. So, observing this defection, the equilibrium in which the currency of the country imposing the CIA is the one valued would be focal.

There are, however, other equilibria in the event that only one country imposes a CIA. In one of them, only the currency of the country **not** imposing the CIA has value.[14] Clearly, this equilibrium is one of autarky for home

[14] Another possible nonstationary equilibrium entails both currencies having value. In

agents since it is impossible to purchase the goods produced in the country imposing the CIA since that currency has no value. Thus home agents have no income. If this was the equilibrium selected in the event the home country defected from a monetary union, then clearly that defection would not be desirable and monetary union would indeed be an equilibrium. Thus our result clearly requires the selection of a particular equilibrium but one which seems quite natural.

Proposition 6 implies that the monetary union is not an equilibrium. Individually governments have an incentive to create a demand for local currency by imposing local CIA constraints. The resulting demand for home currency creates a basis for the inflation tax and the fact that the other government does not impose a CIA constraint implies that home citizens do not lose liquidity. Thus the monetary union is destroyed and, from Proposition 6, the resulting equilibrium entails the imposition of local CIA by at least one country.

4.3 Nash Equilibrium

The remaining issue is determining the equilibrium of the game between governments. Proposition 6 implies that at least one of the governments will impose a CIA. However, it leaves open the issue of whether both governments will impose these restrictions. While requiring local currency for purchases does create a base for an inflation tax, it also reduces the liquidity of home agents. This was not an issue in considering the defection from a configuration in which neither country imposed a CIA but, starting from a configuration in which both countries impose a CIA, there are some liquidity gains for domestic citizens from not requiring local currency.

These liquidity gains increase with uncertainty in tastes. So if there are no taste shocks, then a country should prefer to use its own currency as a shield against the inflation of another country.[15] Formally, this leads to:

Proposition 7 *If the variance of taste shocks is sufficiently small, then if one country imposes a local CIA, the other will too. Consequently, the equi-*

this case, the holders of the foreign currency would have to be compensated for the loss of liquidity associated with holding that currency.

[15]This is essentially the point made by Fischer [1982] concerning the gains to a national currency.

librium of the game will entail both countries imposing local CIA constraints and setting $\sigma = Z$.

Proof. Assume that the variance of taste shocks is zero. The fact that both countries will inflate at $\sigma = Z$ when both impose local CIA constraints comes directly from Proposition 3. The foreign country gets a payoff of $V^{LC*}(Z, Z)$ in this equilibrium. To see why each country has an incentive to impose a local CIA, consider the defection of the foreign country from a conjectured equilibrium in which both countries impose constraints and inflate at rate Z. Let $V^{NLC*}(Z)$ denote the payoff of the foreign country given that the home country continues to inflate at rate Z. From Proposition 3, $V^{LC*}(Z, Z) > V^{LC*}(0, Z)$ since the foreign government has an incentive to inflate at rate Z. Further, $V^{NLC*}(Z) = V^{LC*}(0, Z)$ given that there are no gains to having a local currency if there are no taste shocks and no inflation taxes to collect. Hence, $V^{NLC*}(Z) < V^{LC*}(Z, Z)$ so that the both countries imposing local CIA and inflating at rate Z is an equilibrium. By continuity, if the variability of taste shocks is sufficiently small, then local CIA constraints will be imposed and inflation rates will be optimally set at Z. ■

Thus, given propositions 6 and 7, the monetary regime game has the structure of a prisoners' dilemma game: there is a cooperative outcome which is jointly optimal but is not an equilibrium. As in that extensive literature, the gains from monetary union are only enjoyed if countries cooperate in the creation and enforcement of monetary union.

5 Conclusions

The goal of this paper was to provide a basic framework for analyzing the gains, both potential and effective, to monetary union. To do so required two steps.

The first was the construction of a model to assess the gains to the creation of a common currency. The main hurdle in the theoretical analysis was to generate money demand. This is accomplished here by the **optimal** imposition of cash-in-advance constraints by both countries. Given these constraints, households who face taste shocks are frequently stuck with the "wrong portfolio" of consumption goods. Further, these households face an inflation tax imposed by foreign governments. By eliminating control over their money supplies through the creation of a monetary union, countries can jointly increase the welfare of citizens. Thus, as suggested by the European Commission's report on monetary union, the gains arise from more efficient allocations and price stability.

The second piece of the analysis was understanding how countries could reap these gains. In this regard, our main finding is that monetary union is a monetary regime unlikely to be established by non-cooperating countries since each, acting independently, could prefer to impose a local currency requirement (assuming that taste shocks are not too variable) and inflate. Put in other terms, monetary union can be obtained only through the joining of sovereign countries to a cooperative scheme involving commitment.

There are a number of natural extensions of our analysis. First, extending the analysis to a multi-country world seems feasible and desirable. This case would allow a more interesting analysis of the game in which countries choose to join a monetary union or not since, in contrast to the two country case, the defection of one country does not destroy the union.

Second, in characterizing these (perhaps modest) gains to monetary union, this paper has avoided some potential costs of this institution.[16] Returning to the analysis of Mundell, our model clearly lacks various sources of aggregate uncertainty that may give rise to the use of monetary policy as a stabilization device. Extending our paper will allow us to assess the magnitude of this loss of a stabilization tool relative to the gains from monetary union already identified in our analysis.

Third, our model of monetary union assumes a very strong centralized monetary authority. It is of interest to consider the implications of a weak central bank whose policy can be influenced by the fiscal policy choices of constituent governments. This is also a topic for our future work.[17]

Finally, the model can be extended to study dollarization: a regime in which only a single country imposes a CIA. Proposition 7 argued that this was not an equilibrium if taste shocks were not highly volatile. However, if tastes are variable enough, then the equilibrium entail a form of dollarization in which only a single country imposes a CIA. In this case, the normal form game has a Battle of the Sexes structure. Further, this result may also arise if there is an asymmetry in the size and/or openness of countries. Understanding dollarization merits further work.

[16] Of course, we do not claim that there are no other gains to monetary union. However, the gains we have identified do coincide with those stressed by the European Commission in its assessment of the EMU.

[17] See Sibert [1992] and Chari-Kehoe [1997] for results in this direction.

6 References

Aizenman, J., "Competitive Externality and Optimal Seigniorage," *Journal of Money, Credit and Banking*, 24 (1992), 61-71.

Bryant, J. and N. Wallace, "A Price Discrimination Analysis of Monetary Policy," *Review of Economic Studies*, 51 (1984), 279-88.

Canzoneri, M., "Adverse Incentives in the Taxation of Foreigners," *Journal of International Economics*, 27 (1989), 283-97.

Canzoneri, M. and A. M. Rogers, "Is the European Community an Optimal Currency Area? Optimal taxation versus the Cost of Multiple Currencies," *American Economic Review*, 80 (1990), 419-433.

Casella A. and J. Feinstein, "Management of a Common Currency," in *A European Central Bank?*, M. de Cecco and A. Giovannini (eds), Cambridge University Press, 1991.

Chang, R., "Bargaining a Monetary Union," *Journal of Economic Theory*, 66 (1995), 89-112.

Chari, V.V. and P. Kehoe, "On the Need for Fiscal Constraints in a Monetary Union," Federal Reserve Bank of Minneapolis, September 1997.

Christiano, L. and M. Eichenbaum, "Liquidity Effects and the Monetary Transmission Mechanism," *American Economic Review*, 82 (1992), 344-53.

Dixit, A., "Strategic Aspects of Trade Policy," in *Advances in Economic Theory*, ed. by Truman Bewley, Cambridge University Press:Cambridge, 1987.

Emerson,M., D. Gros, A. Italianer, J. Pisani-Ferry and J. Reichenback, *One Market One Money*,Oxford University Press, 1992

Feldstein, M., "The Political Economy of the European Economic and Monetary Union: Political Sources of an Economic Liability," *Journal of Economic Perspectives*,11 (1997), 23-42.

Fischer, S., "Seigniorage and the Case for a National Money," *Journal of Political Economy*, 90 (1982), 295-313.

Fuerst, T., "Liquidity, Loanable Funds, and Real Activity," *Journal of Monetary Economics*, 29 (1992), 3-24.

Inman, R. and D. Rubinfeld, "Rethinking Federalism," *Journal of Economic Perspectives*,11 (1997), 43-62.

Kareken, J. and N. Wallace, "The Indeterminacy of Equilibrium Exchange Rates," *Quarterly Journal of Economics*, 96 (1981),207-22.

Krugman, P., "What do we need to know about the International Monetary System?" in *Understanding Interdependence -The Macroeconomics of the Open Economy*, ed. by Peter Kenen, Princeton University Press, 1995, 507-30.

Lucas, R.L., "Liquidity and Interest Rates," *Journal of Economic Theory*, 50 (1990), 237-64.

Mundell, R. "A Theory of Optimum Currency Areas," *American Economic Review*, 51 (1961), 657-665.

Obstfeld, M., "Open-Economy Macroeconomics: Developments in Theory and Practice," NBER Working Paper #6319, December 1997.

Obstfeld, M. and K. Rogoff, *Foundations of International Macroeconomics*, MIT Press: Cambridge, 1997.

Sargent, T., *Dynamic Macroeconomic Theory*, Harvard University Press: Cambridge, Ma. 1987.

Sibert, A.,"Government Finance in a Common Currency Area," *Journal of International Money and Finance*, 11 (1992), 567-78.

Wyplosz, C. , "EMU: Why and How It Might Happen," *Journal of Economic Perspectives*,11 (1997), 3-22.

A Appendix 1

In this appendix, we characterize the steady equilibrium of a world economy with two currencies in which: (i) neither government imposes a CIA and (ii) money creation rates are zero in both countries. After describing the economy, we turn to a proof of Proposition 5. In principle, goods in each of the countries can be purchased using either currency. Hence, period t prices are given by $(p_t^h, p_t^{*h}, p_t^f, p_t^{*f})$ where p_t^h is the price of home goods in home currency, p_t^{*h} is the price of home goods in foreign currency, p_t^f is the price of foreign goods in home currency and p_t^{*f} is the price of foreign goods in foreign currency.

The optimization problem

For the representative agent in home country, the optimization problem is:

$$\max_{\substack{c_t^h, c_t^f, \\ \alpha, \beta, \gamma \\ n_t \epsilon [0,1]}} E_\theta \left[\theta \ln c_{t+1}^h + (1-\theta) \ln c_{t+1}^f\right] - g(n_t) \tag{18}$$

subject to:

$$\alpha p_t^h n_t = \beta c_{t+1}^h p_{t+1}^h + \gamma c_{t+1}^f p_{t+1}^f \tag{19}$$

$$(1-\alpha) p_t^{*h} n_t = (1-\beta) c_{t+1}^h p_{t+1}^{*h} + (1-\gamma) c_{t+1}^f p_{t+1}^{*f} \tag{20}$$

where α is the share of his sales of his production of good h realized with home currency, hence of his holding of home currency, β is the share of his consumption (when old) of good h realized with home currency, γ is the share of his consumption (when old) of good f realized with home currency.

The first order conditions imply:

$$\frac{\theta}{c_{t+1}^h} = \lambda \beta p_{t+1}^h + \mu (1-\beta) p_{t+1}^{*h} \tag{21}$$

$$\frac{1-\theta}{c_{t+1}^f} = \lambda \gamma p_{t+1}^f + \mu (1-\gamma) p_{t+1}^{*f} \tag{22}$$

$$g'(n_t) = \lambda \alpha p_t^h + \mu (1-\alpha) p_t^{*h} \tag{23}$$

$$\lambda p_t^h = \mu p_t^{*h} \tag{24}$$

the last condition corresponding to the choice of α. λ and μ are the multipliers associated with (19) and (20).

From these conditions, we get:

$$g'(n_t) = \lambda p_t^h \tag{25}$$

$$\frac{\theta}{c_{t+1}^h} = g'(n_t)\frac{p_{t+1}^h}{p_t^h} \tag{26}$$

$$\frac{1-\theta}{c_{t+1}^h} = g'(n_t)\frac{p_{t+1}^h}{p_t^h} \tag{27}$$

Given equation (24), the consolidated budget constraint can be written as:

$$p_{t+1}^h c_{t+1}^h + p_{t+1}^f c_{t+1}^f = p_t^h n_t \tag{28}$$

which, combined with (26) and (27) implies:

$$1 = g'(n_t)\left[\frac{p_{t+1}^h c_{t+1}^h + p_{t+1}^f c_{t+1}^f}{p_t^h}\right]$$

At steady state with no inflation, this implies that:

$$1 = g'(n)\,n \tag{29}$$

A similar reasoning implies that:

$$1 = g'(n^*)\,n^* \tag{30}$$

Hence, from these two optimality conditions, it is clear that the levels of outputs in such an economy are equal to those obtained in a monetary union with optimal policy. It remains to be seen that the consumption levels are the same. From the money market conditions with constant money supplies, we get:

$$M = \left[\alpha p_t^h + (1-\alpha)\,p_t^f\right] n = \left[\alpha p_{t+1}^h + (1-\alpha)\,p_{t+1}^f\right] n$$

which along with (24) implies that:

$$p_t^h = p_{t+1}^h$$

Replacing this equality in the conditions for consumption levels, we get:

$$c^h = \theta n = c^{*f} \qquad c^f = (1-\theta)\,n = c^{*h}$$

which gives the same consumption patterns as in monetary union with optimal policy. This completes the proof.