On the Relevance of Exchange Rate Regimes for Stabilization Policy

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ABSTRACT

In this paper, we analyze an economy with heterogeneous countries with immobile labor, incomplete international asset markets and nominal rigidities. We show that there are no costs of fixed exchange rates, if fiscal policy is used for stabilization. The result holds independently of the type of price stickiness. The assumption of lack of labor mobility is crucial, instead. If labor was mobile across countries, there would be costs of a monetary union.

I. Introduction

This paper revisits the issues in the optimal currency area literature, as in Mundell (1961) and a more recent literature on the optimal choice of an exchange rate regime. What are the costs of a fixed exchange rate regime when there is a role for stabilization policy? We address this question allowing for heterogeneity in the shocks and the response to them, restrictions on the mobility of factors and incompleteness of asset markets, as is standard in the optimal currency area literature. The main difference of our approach is that we take into account that fiscal instruments may be used fully for stabilization policy, in the absence of independent monetary policy instruments.

In the literature on optimal stabilization in the open economy, because of some form of nominal rigidity, monetary policy has a short run, stabilization, role, in response to shocks that differ across countries, or that have differing effects, because of differences in the extent or type of the nominal rigidity. Because of this heterogeneity it is common to infer that there are costs of coordinated monetary policies, either through a fixed exchange rate regime or a monetary union. These costs are taken to be higher the stronger are the asymmetries, the more severe are the nominal rigidities, the more pronounced is the incompleteness of international asset markets; the less mobile labor is, and, finally, the less able is fiscal policy in effectively stabilizing the national economies (Corsetti, 2005).

We show that when both fiscal and monetary policies are considered jointly with the same flexibility in response to shocks, the loss of the country specific monetary tool is of no cost. This is true irrespective of the asymmetry in shocks or response to these and the severity of the nominal rigidities. The elements that are crucial in assessing the costs of a single monetary policy are the two last ones in the list by Corsetti above, but labor mobility works in the opposite way to the conventional wisdom. Fiscal and monetary policy are able to eliminate the costs of a monetary union only if labor is not mobile.

We consider a standard cash-in-advance model where firms may be restricted in the setting of prices. Each country specializes in the production of an internationally tradeable good with labor only that is not mobile across countries. The consideration of nontradeable goods would not change the results. Tax instruments are standard state-contingent labor income and consumption taxes. There is state-contingent private debt inside each country in zero net supply and noncontingent nominal public debt in each currency that can be traded internationally.

Related literature reassesses Milton Friedman's case for exchange rate flexibility, as a way of side-stepping the rigidity in relative price movements. Recent examples in the debate are, for instance, Devereux and Engel (2003) and Duarte and Obstfeld (2004).[1] Devereux and Engle (2003) provide an example with local currency pricing where exchange rate flexibility is useless. Duarte and Obstfeld (2004) respond, showing that exchange rate flexibility, can still be of use in a more complex environment, with non tradeable goods. Even if exchange rate movements cannot affect the relative prices of goods, because of sticky prices and pricing to market, they can still affect the allocations and improve welfare. Because the optimal regime depends on the degree of exchange rate pass-through, it is important to relax the exogeneity of the price setting restrictions. Corsetti and Pesenti (2002) do this and show that there are two self validating regimes, one with fixed and another with flexible exchange rates. The flexible exchange rate regime obviously provides higher welfare. We add to this debate by showing that the claims hinge on the focus on monetary policy only.[2]

Once the choice of the exchange rate regime is considered in the context of the full choice of policy instruments including tax and debt policy, exchange rate flexibility can be replaced with a gain by fiscal instruments. In particular it is possible to implement the set of allocations under flexible prices with a fixed exchange rate.

Cooper and Kempf (2004) make a similar point in a very different context. They explicitly model the Mundellian trade-off between the benefits of a monetary union in reducing transaction costs and the costs of the union in the ability to stabilize. Stabilization in their set up are risk sharing transfers between agents. If the government is able to stabilize using alternative fiscal instruments, then there are no costs of a monetary union.

In the same direction, but unable to establish the irrelevance result for the lack of fiscal instruments are papers such as Gali and Monacelli (2005) and Ferrero (2005). In Gali and Monacelli (2005) the government chooses the optimal level of public consumption in a monetary union with lump-sum taxes. Ferrero (2005) considers that lump-sum taxes are not available. The monetary policy instrument is the interest rate and the fiscal policy consists in choosing state-noncontingent public debt and state-contingent taxes on output by firms. In both papers it is established that the choice of fiscal policy helps attaining higher welfare. The major difference between our set up and the one of Ferrero (2005) is that we consider not only state-contingent labor income taxes but also consumption taxes.

The assumption of state-contingency of taxes does not have an obvious parallel in the present institutional arrangements, however it is a fair assumption when the object of the analysis is the optimal design of economic institutions. If there are fundamental reasons for taxes not to be state contingent, those reasons probably also affect the choice of monetary policy, and yet the assumption of state-contingent monetary policy is the standard one. The assumption of state-contingent fiscal policy is also the common one in the literature on optimal fiscal and monetary policy in closed economies.

Other related literature is on optimal fiscal and monetary policy in small open economies.

Nicolini and Hevia (2004) consider a small open economy with flexible exchange rates and state-contingent assets. Prices are set in advance. In that set up the second best, flexible price equilibrium is implementable, but exchange rates must move across states. Benigno and Paoli (2004) is other related work.

The paper proceeds as follows. In Section 2 we present the model. In Section 3, we show that the set of implementable allocations in a flexible world where both prices and exchange rates are flexible can be implemented with constant producer price levels and fixed exchange rates. The result follows that neither sticky prices nor the exchange rate regime restrict the set of allocations. Furthermore, the set of allocations under flexible prices and exchange rates is optimal. Therefore, as argued in Section 4, there is no cost of fixed exchange rates, independently of the degree or type of price rigidity. Section 5 addresses the issue of labor mobility showing that with labor mobility the results are not obtained.

II. The Model

The economy has two countries of equal size, the home country and the foreign country. In each country there is a representative household, a continuum of firms and a government. Each firm produces a distinct, perishable consumption good with only labor. In each period $t = 0, 1, ..., T$, where T can be made arbitrarily large,[3] the economy experiences one of finitely many events s_t. The initial realization s_0 is given. The set of all possible events in period t is denoted by S_t, the history of these events up to and including period t, which we call state at t, $(s_0, s_1, ..., s_t)$, is denoted by s^t, and the set of all possible states in period t is denoted by S^t. The number of all possible events in period t is $\#S_t$ and the number of all possible states in period t is $\#S^t$. All the relevant variables for this world economy are a function of the state, s_t, but to simplify the notation we do not index formally the variables to the state.

There are markets for goods, labor, money, state-contingent debt and state-noncontingent debt. The labor market is segmented across countries. The state-contingent debt market is segmented across countries and across households and governments. The goods and the state-noncontingent debt are tradeable across countries and agents. Firms set prices every period with contemporaneous information.

A. The households

The preferences of the home households are described by the expected utility function:

$$U = E_t \sum_{t=0}^{T} \beta^t u\left(C_{h,t}, C_{f,t}, L_t\right)$$

$C_{h,t}$ is the home composite consumption good that aggregates the goods produced by the home firms,

$$C_{h,t} = \left[\int_0^1 c_{h,t}(i)^{\frac{\theta-1}{\theta}} di\right]^{\frac{\theta}{\theta-1}}, \theta > 1,$$

There is a continuum of home firms in the unit interval $[0, 1]$, indexed by i. $c_{h,t}(i)$ is the consumption of the good produced by firm i. $C_{f,t}$ is the foreign composite consumption good aggregating the goods produced by the foreign firms,

$$C_{f,t} = \left[\int_0^1 c_{f,t}(j)^{\frac{\theta-1}{\theta}} dj\right]^{\frac{\theta}{\theta-1}}, \theta > 1.$$

There is also a continuum of these firms in the unit interval, indexed by j. L_t is leisure time and is equal to $1 - N_t$, where N_t is total time devoted to production.

The preferences of the foreign households are described by an identical expected utility function:

$$U = E_t \sum_{t=0}^{T} \beta^t u\left(C_{h,t}^*, C_{f,t}^*, L_t^*\right),$$

where $C_{h,t}^*$ is the foreign households composite consumption of the goods produced at the home country and $C_{f,t}^*$ is the foreign households composite consumption of the goods produced in the foreign country.

The representative household of the home country at the beginning of each period $t = 0, 1, ..., T+1$,[4] uses the nominal wealth $\mathbb{W}_t$ to buy M_t (home money), $B_{h,t}$ (home government noncontingent debt), $B_{f,t}$ (foreign government noncontingent debt) and Z_{t+1} (home private state-contingent debt). The home government noncontingent debt pays the gross return R_t in the domestic currency at the beginning of the following period, and the foreign government noncontingent debt pays gross return R_t^* in foreign currency. The price, normalized by the probability of occurrence of the state, at date t of one unit of domestic currency at a particular state at date $t+1$ is $z_{t+1,t}$. There is no government state-contingent debt and the home household cannot buy foreign money or foreign contingent debt. The price of one unit of foreign currency in units of home currency is ε_t. Thus, the following restrictions must be satisfied, respectively, for the home and the foreign households,

$$M_t + B_{h,t} + \varepsilon_t B_{f,t} + E_t Z_{t+1} z_{t+1,t} \leq \mathbb{W}_t. \tag{1}$$

$$M_t^* + \frac{B_{h,t}^*}{\varepsilon_t} + B_{f,t}^* + E_t Z_{t+1}^* z_{t+1,t}^* \leq \mathbb{W}_t^*.$$

In the home country there are taxes on the consumption of home produced goods, $\tau_{h,t}$, on the consumption of foreign produced goods, $\tau_{f,t}$, labor income $\tau_{n,t}$ and profits. As the tax on profits is a lump-sum tax it is optimal that all profits be taxed away, so that the net profits are zero. The revenue generated by this tax is used to subsidize labor in production and it is just enough to neutralize the mark-up distortion in production. There are corresponding taxes in the foreign country.

Money is used to purchase goods according to the following cash-in-advance constraints, for the home and foreign country, respectively,

$$(1+\tau_{h,t})P_{h,t}C_{h,t} + (1+\tau_{f,t})\varepsilon_t P^*_{f,t}C_{f,t} \leq M_t, \tag{2}$$

$$(1+\tau^*_{h,t})\frac{P_{h,t}}{\varepsilon_t}C^*_{h,t} + (1+\tau^*_{f,t})P^*_{f,t}C^*_{f,t} \leq M^*_t. \tag{3}$$

$P_{h,t}$ is the price of the home composite good in units of domestic currency

$$P_{h,t} = \left[\int_0^1 p_{h,t}(i)^{1-\theta} di\right]^{\frac{1}{1-\theta}}, \theta > 1,$$

where $p_{h,t}(i)$ is the price of home good i in units of domestic currency. Similarly, $P^*_{f,t}$ is the price of the foreign composite good in units of foreign currency,

$$P^*_{f,t} = \left[\int_0^1 p^*_{f,t}(i)^{1-\theta} di\right]^{\frac{1}{1-\theta}}, \theta > 1.$$

The wealth home households bring to date $t+1$ is

$$\mathbb{W}_{t+1} = M_t + B_{h,t}R_t + \varepsilon_{t+1}B_{f,t}R_t^* + Z_{t+1} + (1-\tau_{n,t})W_t N_t - (1+\tau_{h,t})P_{h,t}C_{h,t} - (1+\tau_{f,t})\varepsilon_t P_{f,t}^* C_{f,t}. \quad (4)$$

Using (1) and (4) can write the home household budget constraint more compactly as

$$M_{t+1} + B_{h,t+1} + \varepsilon_{t+1}B_{f,t+1} + E_{t+1}Z_{t+2}z_{t+2,t+1} \leq M_t + B_{h,t}R_t + \varepsilon_{t+1}B_{f,t}R_t^* + Z_{t+1} + (1-\tau_{n,t})W_t N_t - (1+\tau_{h,t})P_{h,t}C_{h,t} - (1+\tau_{f,t})\varepsilon_t P_{f,t}^* C_{f,t}, \text{ , all } s^t,\ 0 \leq t \leq T$$

The intertemporal budget constraints for period t for the home household can be written as

$$\sum_{s=0}^{T-t} E_t Q_{t,t+s+1}\left[(1+\tau_{h,t+s})P_{h,t+s}C_{h,t+s} + (1+\tau_{f,t+s})\varepsilon_{t+s}P_{f,t+s}^* C_{f,t+s} - (1-\tau_{n,t+s})W_{t+s}N_{t+s}\right] + \sum_{s=0}^{T-t} E_t Q_{t,t+s+1}\left[M_{t+s}\left(\frac{Q_{t,t+s}}{Q_{t,t+s+1}} - 1\right)\right] \leq \mathbb{W}_t, \text{ all } s^t,\ 0 \leq t \leq T,$$

where $Q_{t,t+s} \equiv \beta^{t+s}\frac{P_{h,t}(1+\tau_{h,t})}{P_{h,t+s}(1+\tau_{h,t+s})}\frac{u_{C_h}(t+s)}{u_{C_h}(t)}$, $t \geq 0$, using the terminal condition $\mathbb{W}_{T+1} \geq 0$.

Among the first order conditions for the home and foreign households are the intertemporal conditions,

$$\frac{u_{C_h}(t-1)}{P_{h,t-1}(1+\tau_{h,t-1})} = \beta R_{t-1}E_{t-1}\left[\frac{u_{C_h}(t)}{P_{h,t}(1+\tau_{h,t})}\right], \text{ all } s^t,\ 1 \leq t \leq T, \quad (5)$$

$$\frac{\varepsilon_{t-1}u_{C_h}(t-1)}{P_{h,t-1}(1+\tau_{h,t-1})} = \beta R_{t-1}^* E_{t-1}\left[\frac{\varepsilon_t u_{C_h}(t)}{P_{h,t}(1+\tau_{h,t})}\right], \text{ all } s^t,\ 1 \leq t \leq T, \quad (6)$$

$$\frac{u_{C_h^*}(t-1)}{P_{h,t-1}(1+\tau_{h,t-1}^*)} = \beta R_{t-1}E_{t-1}\left[\frac{u_{C_h^*}(t)}{P_{h,t}(1+\tau_{h,t}^*)}\right], \text{ all } s^t,\ 1 \leq t \leq T, \quad (7)$$

$$\frac{\varepsilon_{t-1} u_{C_h^*}(t-1)}{P_{h,t-1}(1+\tau_{h,t-1}^*)} = \beta R_{t-1}^* E_{t-1}\left[\frac{\varepsilon_t u_{C_h^*}(t)}{P_{h,t}(1+\tau_{h,t}^*)}\right], \text{ all } s^t,\ 1 \le t \le T, \tag{8}$$

the intratemporal conditions,

$$\frac{u_L(t)}{u_{C_h}(t)} = \frac{W_t(1-\tau_{n,t})}{P_{h,t}R_t(1+\tau_{h,t})}, \text{ all } s^t,\ 0 \le t \le T \tag{9}$$

$$\frac{u_{C_h}(t)}{u_{C_f}(t)} = \frac{(1+\tau_{h,t})P_{h,t}}{(1+\tau_{f,t})\varepsilon_t P_{f,t}^*}, \text{ all } s^t,\ 0 \le t \le T \tag{10}$$

$$\frac{u_{L_t^*}(t)}{u_{C_f^*}(t)} = \frac{W_t^*(1-\tau_{n,t}^*)}{P_{f,t}^* R_t^*(1+\tau_{f,t}^*)}, \text{ all } s^t,\ 0 \le t \le T \tag{11}$$

$$\frac{u_{C_h^*}(t)}{u_{C_f^*}(t)} = \frac{(1+\tau_{h,t}^*)P_{h,t}}{(1+\tau_{f,t}^*)\varepsilon_t P_{f,t}^*}, \text{ all } s^t,\ 0 \le t \le T \tag{12}$$

Using these first order conditions, as well as the cash in advance constraints, in the intertemporal budget constraints satisfied with equality, we get the period t implementability conditions for the home country

$$\sum\nolimits_{s=0}^{T-t} \beta^s E_t\left[\left(u_{C_h}(t+s)\, C_{h,t+s} + u_{C_f}(t+s)\, C_{f,t+s} - u_L(t+s)\, N_{t+s}\right)\right] = \mathbb{W}_t \frac{u_{C_h}(t)}{P_{h,t}(1+\tau_{h,t})}, \text{ all } s^t,\ 0 \le t \le T \tag{13}$$

and for the foreign country,

$$\sum\nolimits_{s=0}^{T-t} \beta^s E_t\left[\left(u_{C_h^*}(t+s)\, C_{h,t+s}^* + u_{C_f^*}(t+s)\, C_{f,t+s}^* - u_{L^*}(t+s)\, N_{t+s}^*\right)\right] = \mathbb{W}_t^* \frac{u_{C_f^*}(t)}{P_{f,t}^*(1+\tau_{f,t}^*)}, \text{ all } s^t,\ 0 \le t \le T \tag{14}$$

B. The government

The government of each country includes both the fiscal authority and the monetary authority. The home government issues non state-contingent debt, $B_{h,t}+B^*_{h,t}$, and money, M^s_t, makes expenditures in the home consumption good G_t, and taxes labor income and private consumption. The nominal financial responsibilities of the home government at the start of period t are $\mathbb{W}^g_t$, which can be financed by issuing money and public debt

$$M^s_t + B_{h,t} + B^*_{h,t} = \mathbb{W}^g_t.$$

The nominal financial responsibilities the home government brings to the next period are

$$\mathbb{W}^g_{t+1} = M^s_t + R_t B_{h,t} + R_t B^*_{h,t} + P_{h,t} G_t - \tau_{h,t} P_{h,t} C_{h,t} - \tau_{f,t} \varepsilon_t P^*_{f,t} C_{f,t} - \tau_{n,t} W_t N_t$$

We are assuming that the government taxes all profits of domestic firms and gives the proceeds as a subsidy to production of those firms. These two conditions can be written as

$$M^s_0 + B_{h,0} + B^*_{h,0} = \mathbb{W}^g_0$$

and

$$\begin{aligned} & M^s_{t+1} + B_{h,t+1} + B^*_{h,t+1} \\ = \; & M^s_t + R_t B_{h,t} + R_t B^*_{h,t} + P_{h,t} G_t - \tau_{h,t} P_{h,t} C_{h,t} - \tau_{f,t} \varepsilon_t P^*_{f,t} C_{f,t} - \tau_{n,t} W_t N_t, \text{ all } s^t,\ 0 \le t \le T. \end{aligned}$$

The home government period t intertemporal budget constraint is

$$\sum_{s=0}^{T-t} E_t Q_{t,t+s+1} \left[\tau_{h,t+s} P_{h,t+s} C_{h,t+s} + \tau_{f,t+s} \varepsilon_{t+s} P^*_{f,t+s} C_{f,t+s} + \tau_{n,t+s} W_{t+s} N_{t+s} - P_{h,t+s} G_{t+s}\right] + \sum_{s=0}^{T-t} E_t M^s_{t+s} \left(Q_{t,t+s} - Q_{t,t+s+1}\right) = \mathbb{W}^g_t, \text{ all } s^t,\ 0 \le t \le T.$$

There is a similar condition for the foreign country.

The intertemporal budget constraint of the home country can be obtained by adding up the home government budget constraint and the home representative household budget constraint,

$$\sum_{s=0}^{T-t} E_t Q_{t,t+s+1} \left[P_{h,t+s}\left(C_{h,t+s} + G_{t+s}\right) + \varepsilon_{t+s} P^*_{f,t+s} C_{f,t+s} - W_{t+s} N_{t+s}\right] = \mathbb{W}^e_t, \text{ all } s^t,\ 0 \le t \le T, \tag{15}$$

where $\mathbb{W}^e_t = \mathbb{W}_t - \mathbb{W}^g_t$, are the foreign assets owned by the home country.

C. Firms

In each country there is a continuum of firms in the unit interval. Each firm produces a distinct, perishable consumption good with a technology that depends on labor only. Each home firm i has the production technology

$$Y_{h,t}(i) \le A_t N_t(i)\,, \text{ all } s^t,\ 0 \le t \le T,$$

where $Y_{h,t}(i)$ is the production of good i, $N_t(i)$ is the labor used in the production of good i, and A_t is an aggregate technology shock in the home country. Good i can be used for private and public consumption, $Y_{h,t}(i) = C_{h,t}(i) + C^*_{h,t}(i) + G_t(i)$. The same is true for the goods produced in the foreign country. Each good j produced in the foreign country can be consumed by households or by the foreign government, $Y_{f,t}(j) = C_{f,t}(j) + C^*_{f,t}(j) + G^*_t(j)$. Given price flexibility and that there is a labor subsidy, the first order conditions of profit maximization for home firms are

$$\frac{W_t}{P_{h,t}} = A_t,\ 0 \leq t \leq T, \tag{16}$$

and for foreign firms are

$$\frac{W_t^*}{P_{f,t}^*} = A_t^*,\ 0 \leq t \leq T. \tag{17}$$

D. Equilibrium

A flexible-price equilibrium is a vector $\left\{ \begin{array}{c} C_{h,t}, C_{f,t}, N_t, P_{h,t}, W_t, R_t, \tau_{h,t}, \tau_{f,t}, \tau_{n,t}, \\ M_t^S, M_t, B_{h,t}, B_{f,t}, B_t, Z_{t+1}, z_{t+1,t}, \varepsilon_t \\ C_{h,t}^*, C_{f,t}^*, N_t^*,\ P_{f,t}, W_t^*, R_t^*, \tau_{h,t}^*, \tau_{f,t}^*, \tau_{n,t}^*, \\ M_t^{*S}, M_t^*, B_{h,t}^*, B_{f,t}^*, B_t^*, Z_{t+1}^*, z_{t+1,t}^* \end{array} \right\}$ such that,

(a) Given the initial wealth levels, prices and policy the households choose the relevant quantities that solve their problems;

(b) Firms given prices and policy choose the relevant quantities that solve their problems;

(c) For initial public debts the governments satisfy their budget constraints;

(d) The markets are in equilibrium:

$$C_{h,t} + C_{h,t}^* + G_t = A_t N_t \tag{18}$$

$$C_{f,t} + C_{f,t}^* + G_t^* = A_t^* N_t^* \tag{19}$$

$$M_t^S = M_t \tag{20}$$

$$M_t^{*S} = M_t^* \tag{21}$$

$$Z_{t+1} = 0 \tag{22}$$

$$Z^*_{t+1} = 0 \tag{23}$$

The equilibrium in the labor and non-contingent bond markets was already imposed.

III. Equilibria under flexible prices

In this section we show that the set of equilibria under flexible prices can be implemented with policies such that the price level in either country will be constant over time, and so will the nominal exchange rate. The proposition stating this result follows:

Proposition 1. *Any flexible equilibrium allocation can be implemented with* $P_{h,t} = P_{h,0}$, $P^*_{f,t} = P^*_{f,0}$, $\varepsilon_t = \varepsilon_0$ *and* $R_t = R^*_t$.

Proof: Without loss of generality we take $T = 1$. In the beginning of period $t = 2$ the asset market opens to liquidate debts. This means that the wealth of the households in period $t = 2$, in either country, is zero, $\mathbb{W}_2 = 0$ and $\mathbb{W}^*_2 = 0$.

The proof involves counting equations and unknowns. We take as given an equilibrium allocation $\left\{C_{h,t}, C_{f,t}, N_t, C^*_{h,t}, C^*_{f,t}, N^*_t,\ t = 0, 1\right\}$ under flexible prices and exchange rates. We show that there are constant prices with $P_{h,t} = P_{h,0}$, $P^*_{f,t} = P^*_{f,0}$, and fixed exchange rates, $\varepsilon_t = \varepsilon_0$, which implies that $R_t = R^*_t$, that satisfy the equilibrium equations for that allocation which are: (2), (3), and (5)-(23). First, this allocation satisfies trivially the two feasibility constraints, as it is an equilibrium allocation.

For given $P_{h,0}$, $P^*_{f,0}$, ε_0 we use the remaining equilibrium conditions to determine the values for the policy variables and remaining prices. The firms' conditions determine W_t and W^*_t

$$\frac{W_t}{P_{h,0}} = A_t, t = 0, 1$$

$$\frac{W^*_t}{P^*_{f,0}} = A^*_t, t = 0, 1.$$

The period 0 intertemporal budget constraints for the two representative households are

$$\sum\nolimits_{j=0}^{1} \beta^j E_0 \left[\left(u_{C_h}(j)\, C_{h,j} + u_{C_f}(j)\, C_{f,j} - u_L(j)\, N_j \right) \right] = \mathbb{W}_0 \frac{u_{C_h}(0)}{P_{h,0}(1+\tau_{h,0})}$$

and

$$\sum\nolimits_{j=0}^{1} \beta^j E_0 \left[\left(u_{C^*_h}(j)\, C^*_{h,j} + u_{C^*_f}(j)\, C^*_{f,j} - u_{L^*}(j)\, N^*_j \right) \right] = \mathbb{W}^*_0 \frac{u_{C^*_h}(0)}{\frac{P_{h,0}}{\varepsilon_0}(1+\tau^*_{h,0})}$$

which are satisfied by appropriately choosing $\tau_{h,0}$ and $\tau^*_{h,0}$.

Given a common process for the nominal interest rate

$$R_t = R^*_t \tag{24}$$

to be determined later, and $\tau_{h,0}$ and $\tau^*_{h,0}$, can use the following equations

$$\frac{u_{C_h}(0)}{(1+\tau_{h,0})} = \beta R_0 E_0 \frac{u_{C_h}(1)}{(1+\tau_{h,1})} \tag{25}$$

$$\frac{u_{C^*_h}(0)}{(1+\tau^*_{h,0})} = \beta R_0 E_0 \frac{u_{C^*_h}(1)}{(1+\tau^*_{h,1})} \tag{26}$$

$$u_{C_h}(1)\, C_{h,1} + u_{C_f}(1)\, C_{f,1} - u_L(1)\, N_1 = \mathbb{W}_1 \frac{u_{C_h}(1)}{P_{h,0}(1+\tau_{h,1})},\ \ s^1 \in S^1$$

$$u_{C_h^*}(1)\, C_{h,1}^* + u_{C_f^*}(1)\, C_{f,1}^* - u_{L^*}(1)\, N_1^* = \mathbb{W}_1^* \frac{u_{C_h^*}(1)}{\frac{P_{h,0}}{\varepsilon_0}(1+\tau_{h,1}^*)},\ \ s^1 \in S^1 \tag{27}$$

to determine $\tau_{h,1}$, $\tau_{h,1}^*$, $\mathbb{W}_1$ and $\mathbb{W}_1^*$.

Can use the intratemporal conditions

$$\frac{u_L(t)}{u_{C_h}(t)} = \frac{W_t(1-\tau_{n,t})}{P_{h,0}R_t(1+\tau_{h,t})}, t = 0, 1$$

$$\frac{u_{C_h}(t)}{u_{C_f}(t)} = \frac{(1+\tau_{h,t})P_{h,0}}{(1+\tau_{f,t})\varepsilon_0 P_{f,0}^*}, t = 0, 1$$

$$\frac{u_{L_t^*}(t)}{u_{C_f^*}(t)} = \frac{W_t^*(1-\tau_{n,t}^*)}{P_{f,0}^* R_t(1+\tau_{f,t}^*)}, t = 0, 1$$

$$\frac{u_{C_h^*}(t)}{u_{C_f^*}(t)} = \frac{(1+\tau_{h,t}^*)P_{h,0}}{(1+\tau_{f,t}^*)\varepsilon_0 P_{f,0}^*}, t = 0, 1$$

to determine $\tau_{n,t}$, $\tau_{f,t}$, $\tau_{n,t}^*$, $\tau_{f,t}^*$, for $t = 0, 1$.

Can use the cash in advance constraints

$$(1+\tau_{h,t})P_{h,0}C_{h,t} + (1+\tau_{f,t})\varepsilon_0 P_{f,0}^* C_{f,t} = M_t, t = 0, 1$$

$$(1+\tau_{h,t}^*)\frac{P_{h,0}}{\varepsilon_0}C_{h,t}^* + (1+\tau_{f,t}^*)P_{f,0}^* C_{f,t}^* = M_t^*, t = 0, 1$$

to determine M_t and M_t^*, for $t = 0, 1$.

Can use the home country intertemporal budget constraints to determine the nominal interest rates R_t. The budget constraints for period $t = 1$ are

$$\mathbb{W}_1^e = \frac{1}{R_1}\left[P_{h,0}\left(C_{h,1}+G_1\right)+\varepsilon_0 P_{f,0}^* C_{f,1}-W_1 N_1\right], s^1 \in S^1$$

which give $\#S^1$ interest rates R_1 as a function of the value for $\mathbb{W}_1^e$. Given these values for R_1 the budget constraint for period $t=0$,

$$\begin{aligned}\mathbb{W}_0^e &= \frac{1}{R_0}\left[P_{h,0}\left(C_{h,0}+G_0\right)+\varepsilon_0 P_{f,0}^* C_{f,0}-W_0 N_0\right]+\\ &\quad E_0\frac{Q_{0,1}}{R_1}\left[P_{h,0}\left(C_{h,1}+G_1\right)+\varepsilon_0 P_{f,0}^* C_{f,1}-W_1 N_1\right].\end{aligned}$$

determines uniquely R_0.■

Two observations: Notice that we can support the allocation with a constant price for any good and a common interest rate which is a function of the level of the net foreign assets of the home country in period $t=1$. This, for the case of $t=0,1$, gives one degree of freedom for $\mathbb{W}_1^e$. Also there is a degree of freedom in the choice of ε_0. This proof holds for any finite horizon economy, $t=0,...,T$, with T arbitrarily large. This means that the flexible price allocation can be supported by constant prices and constant exchange rates and there is one degree of freedom for ε_0 and $\#S^{t-1}$ degrees of freedom for $\mathbb{W}_t^e$ for every $t=1,...,T$.

The discussion of the costs of the exchange rate system is interesting only if there is some type of nominal friction. In the following section we assume that firms are restricted in the setting of prices.

IV. Sticky prices

The model considered until now has full flexibility of prices and exchange rates. We now assume that prices are sticky in some or in all goods produced. It would appear that price stickiness, because it introduces restrictions on the setting of prices, would prevent from achieving the allocations in a flexible price equilibrium. However, those restrictions also give more power to monetary policy. We show that there are fiscal policies and a common monetary policy for the different economies that can achieve any flexible price equilibrium allocation even when there are nominal frictions that can be different across countries. These policies are the ones that implement the equilibria with constant prices in the proposition above.

Among several alternative approaches, Calvo (1983) staggered price setting is a commonly used assumption in the sticky price literature. Every period only a share of firms is able to optimally set its price. We assume that the firms set prices in the currency of their country. We could alternatively have assumed local currency pricing, but in that case, the environment would have to include segmentation of the goods markets. Given the result that it is possible to implement the allocations under flexible prices with constant prices and exchange rates, the effects of goods market segmentation can also be eliminated.

The share of firms that can choose optimally the price can be different across economies. In general this leads to inefficient differences in prices across firms. Given that firms in the same country have the same linear technology then the relative price of the goods they produce will not be equal to one. The only case in which this will not occur is when the firms that have the opportunity of choosing a new price decide to maintain their price. The price setting restrictions in this case will not be binding, the producer price level in each country will be constant and equal to an historical producer price level. Proposition 1 states that there are tax rates, money and interest rates such that equilibrium prices can be constant over time and the allocations are the ones in the flexible price economy.

The same reasoning can be applied to any other form of price stickiness; for instance, to the case where prices are set in advance, which is another frequently used type of price stickiness. Specifically the initial prices $P_{h,0}$ and $P^*_{f,0}$ are exogenously given and the other period prices $P_{h,t}$ and $P^*_{f,t}$ may be set in advance for T periods, for a finite T. Again Proposition 1 implies that adding those restrictions to the flexible price economy does not change the equilibrium allocation as long as the policy is adjusted conveniently.

We have established that under sticky prices it is possible to implement the set of allocations under flexible prices with constant exchange rates. It turns out that this set dominates in terms of welfare the set of allocations under sticky prices. We show this in the Appendix. Since agents are heterogeneous, the meaning of welfare dominance is the usual one of a potential Pareto movement where lump sum transfers between agents are implicitly assumed.

The discussion above is summarized in the following proposition.

Proposition 2. *In a world economy with noncontingent bond markets and sticky prices there is no cost of a fixed exchange rate regime, independently of the degree and type of price rigidity.*

Proof: That under sticky prices and fixed exchange rates it is possible to implement the set of equilibrium allocations under sticky prices is a corollary of Proposition 1. It remains to show that the set is optimal. This is shown in the Appendix, once we take a stand on the concept of optimality with heterogeneous agents. We use the concept of potential Pareto move, as if there were lump sum transfers between countries.■

In the particular case of a monetary union in which the monetary authority chooses the same interest rate for all the members, there is an aggregate money demand and a distribution of money among countries that support the equilibrium. Moreover, a common shock in the union does not imply a uniform change in the distribution of liquidity among the members of the union.

V. Labor mobility

In the literature of optimal currency areas the lack of labor mobility has been seen as the main cost of a monetary union. A result of this paper is that the opposite is true. Labor immobility is a necessary condition for the irrelevance of the exchange system with price rigidity.

Full labor mobility implies one additional constraint per state to the equilibrium. The wage net of taxes must be equal across countries. The degrees of freedom that were not used in Proposition 1 to implement the set of flexible price allocations are not enough to satisfy these additional constraints. This is stated in the proposition below.

Proposition 3. *When prices are sticky, in a fixed exchange rate regime (or monetary union), labor immobility is a necessary condition to implement the set of flexible price equilibrium allocations.*

Proof: The relation between net wages is given by the intratemporal conditions

$$W_t(1-\tau_{n,t}) = \frac{u_L\left(t\right)P_{h,0}}{u_{C_h}\left(t\right)}(1+\tau_{h,t})R_t, \text{ for all } s^t$$

$$W_t^*(1-\tau_{n,t}^*) = \frac{u_{L_t^*}\left(t\right)P_{f,0}^*}{u_{C_f^*}\left(t\right)}(1+\tau_{f,t}^*)R_t, \text{ for all } s^t.$$

Full labor mobility implies

$$W_t(1-\tau_{n,t}) = W_t^*(1-\tau_{n,t}^*). \tag{28}$$

Thus, we would have to have

$$\frac{u_L\left(t\right)P_{h,0}}{u_{C_h}\left(t\right)}(1+\tau_{h,t}) = \frac{u_{L_t^*}\left(t\right)P_{f,0}^*}{u_{C_f^*}\left(t\right)}(1+\tau_{f,t}^*) \tag{29}$$

to verify condition (28). There are $\#S^t$ equations of the type (29) but, from Proposition 1, there are only $1 + \#S^{t-1}$ degrees of freedom in determining policy variables. Therefore the conditions for labor mobility (28) cannot be satisfied.■

Notice that the proposition above says that, when prices are sticky, the adoption of a fixed exchange rate system (or a monetary union) does not impose a cost when labor is immobile. Instead, it does when labor is mobile. We are not comparing the optimal allocations with and without labor mobility.

Concluding remarks:

A floating exchange rate system gives each country autonomy over its monetary policy. Under a floating exchange rate system, monetary policies in each country can freely respond to the state of the world. However, in a monetary union there is a unique monetary policy for the members of the union. Thus, there is a loss of instruments of policy, the exchange rate must be constant over time and the nominal interest rate must be equal across countries. Is the loss of these policy instruments a restriction to achieve the optimal equilibrium allocations, presumably those in a floating exchange rate regime?

We show that in an environment with nominal rigidities, whatever the type of price setting PCP (producer currency pricing) or LCP (local currency pricing), the exchange rate regime, whether flexible or fixed exchange rates, is irrelevant once fiscal policy instruments are taken into account. This is the main result of the paper. We also show that, in contrast to the conventional wisdom, in order for the costs of the monetary union to be zero labor cannot be mobile.

The exchange rate regime is irrelevant, first, because the set of implementable allocations under flexible prices can be implemented under sticky prices with constant exchange rates. Furthermore, those allocations under flexible prices dominate in terms of welfare the allocations under sticky prices in the sense that they allow to attain the utility possibilities frontier, for arbitrary Pareto weights.

There is a recent literature on fiscal and monetary policy in the open economy imposing arbitrary restrictions on the fiscal instruments, and therefore unable to obtain the irrelevance results. There is an analogous debate in the closed economy (see Correia, Nicolini and Teles (2004), Siu (2004), Schmitt-Grohe and Uribe (2004), Benigno and Woodford, 2004).

One possible objection to our analysis is that we do not incorporate informational restrictions in the policy choice and also do not take into account lack of ability to commit. The assumptions of private information on the part of the government and inability to commit in the presence of a time inconsistency problem may justify policy that does not respond to contingencies, such as the inflation cap in the analysis in Athey, Atkeson and Kehoe (2005). Since the time inconsistency problem is typically more severe in the choice of monetary policy than fiscal policy, we conjecture that in that more deeply founded environment fiscal policy instruments would be less restricted than monetary ones.

A final remark: We show that there are no costs of a monetary union. However an individual country can be better off inside or outside a union depending on the weights in the union objective function, as well as the structure of the policy game.

APPENDIX

In this appendix we show that for each allocation under sticky prices there is an allocation under flexible prices that gives at least as high welfare to one country without reducing the welfare of the other country.

Assuming that lump sum transfers were feasible between countries, the set of implementable allocations under flexible prices $\left\{C_{h,t}, C_{f,t}, N_t, C^*_{h,t}, C^*_{f,t}, N^*_t\right\}$ as well as initial taxes and exchange rate $\left\{\tau_{h,0}, \tau^*_{h,0}, \varepsilon_0\right\}$ would be characterized by the following conditions:

$$\sum\nolimits_{j=0}^{1} \beta^j E_0 \left[\left(u_{C_h}(j)\, C_{h,j} + u_{C_f}(j)\, C_{f,j} - u_L(j)\, N_j\right)\right] = \mathbb{W}_0 \frac{u_{C_h}(0)}{P_{h,0}(1+\tau_{h,0})}$$

$$\sum\nolimits_{j=0}^{1} \beta^j E_0 \left[\left(u_{C^*_h}(j)\, C^*_{h,j} + u_{C^*_f}(j)\, C^*_{f,j} - u_{L^*}(j)\, N^*_j\right)\right] = \mathbb{W}^*_0 \frac{u_{C^*_h}(0)}{\frac{P_{h,0}}{\varepsilon_0}(1+\tau^*_{h,0})}$$

$$C_{h,t} + C^*_{h,t} + G_t = A_t N_t \tag{A.1}$$

$$C_{f,t} + C^*_{f,t} + G^*_t = A^*_t N^*_t \tag{A.2}$$

We do not impose as a restriction the budget constraint between countries, because we allow for transfers between these. The remaining equilibrium conditions determine the policy and prices. Denote the set of allocations that satisfy these conditions by E.

Given Pareto weights there will be an optimal allocation that can be decentralized with a choice of initial conditions $\mathbb{W}^e_0$. The Pareto weights can be chosen to be such that the optimal allocation is implemented with the actual initial $\mathbb{W}^e_0$.

Under sticky prices the set of equilibrium conditions cannot be summarized by a small set of implementability conditions as under flexible prices. The allocations $\left\{C_{h,t}, C_{f,t}, N_t, C^*_{h,t}, C^*_{f,t}, N^*_t\right\}$ are restricted by

$$\sum\nolimits_{j=0}^{1} \beta^j E_0 \left[\left(u_{C_h}(j)\, C_{h,j} + u_{C_f}(j)\, C_{f,j} - u_L(j)\, N_j\right)\right] = \mathbb{W}_0 \frac{u_{C_h}(0)}{P_{h,0}(1+\tau_{h,0})}$$

$$\sum\nolimits_{j=0}^{1} \beta^j E_0 \left[\left(u_{C^*_h}(j)\, C^*_{h,j} + u_{C^*_f}(j)\, C^*_{f,j} - u_{L^*}(j)\, N^*_j\right)\right] = \mathbb{W}^*_0 \frac{u_{C^*_h}(0)}{\frac{P_{h,0}}{\varepsilon_0}(1+\tau^*_{h,0})}$$

$$\left(C_{h,t} + C^*_{h,t} + G_t\right) \int_0^1 \left(\frac{P_{h,t}(i)}{P_{h,t}}\right)^{-\theta} di = A_t N_t \qquad \text{(A.3)}$$

$$\left(C_{f,t} + C^*_{f,t} + G^*_t\right) \int_0^1 \left(\frac{P_{f,t}(j)}{P_{f,t}}\right)^{-\theta} dj = A^*_t N^*_t \qquad \text{(A.4)}$$

where $D \equiv \int_0^1 \left(\frac{P_{h,t}(i)}{P_{h,t}}\right)^{-\theta} di \geq 1$ and $D^* = \int_0^1 \left(\frac{P_{f,t}(j)}{P_{f,t}}\right)^{-\theta} dj \geq 1$, as well as all the remaining equilibrium equations. $D = 1$ when $\frac{P_{h,t}(i)}{P_{h,t}} = 1$ and $D^* = 1$ when $\frac{P_{f,t}(j)}{P_{f,t}} = 1$. Let the set of allocations that satisfy these restrictions be denoted by E^s.

The set of allocations under flexible prices dominates the set under sticky prices, meaning that for each allocation in E^s there is at least one allocation in E^f with at least one of the goods in larger or equal quantity and none smaller. The intertemporal budget constraints are the same but the feasibility conditions are different, being A.3 and A.4 more restrictive than A.1 and A.2, and there are additional restrictions over E^s that are absent from E^f. Moreover, the restrictions over the allocations under sticky prices are exactly the same only when $P_{h,t}(i) = P_{h,0}$ and $P_{f,t}(j) = P_{f,0}$.

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NOTES

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[1]See also Obstfeld (2004) and Duarte (2004).

[2]On recent work on optimal monetary policy in a currency area see Benigno (2004).

[3]The assumption of a finite, even if arbitrarily large, time horizon considerable simplifies the analysis and is as reasonable an assumption as the more standard one of an infinite horizon.

[4]Notice that the decision on assets is made also in period $T+1$, while the last period in which agents agents produce and consume is T. The assumption that there is an additional subperiod with an assets market for the clearing of debts guarantees that money has value in a finite horizon economy. Agents will want to take money to period $T+1$ to settle debts, that in the aggregate must be with the government. If the finite horizon economy ended with a goods market at T, then sellers would not accept money in period T, and therefore money would not have value, not only in that period but in every period.