Monetary Policy Coordination, Credibility and Structural Asymmetries

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Abstract

The aim of this paper is to discuss the issue of monetary policy coordination in a framework where partners differ not because of idiosyncratic shocks but because of structural asymmetries affecting the conduct of national economic policies. These are introduced at the level of the country size or equivalently at the level of factor productivity. The main result of the paper is that, if coordination of the monetary policy proves to be welfare improving, the gains from cooperation reduce with the size of the economy. We then show that the chances of finding a mutually benefical coordination arrangement may be higher if countries are not too different in size (or in factor productivtity). In this perspective, the coordination of national monetary policies which will take place under EMU between countries presenting large structural differences might be a source of tension among the partners for which the adoption of simple convergence rules or of insurance schemes constitutes no remedy.

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1 Introduction

The prospect of the European Monetary Unification (EMU) has generated a vivid discussion on the effects and the relevance of such an arrangement among European countries. Much of the arguments concern the benefits and the costs or the sustainability of this particular scheme of monetary policy coordination between the potential members of the union[1]. A large fraction of these analysis rests on the literature related to the Mundellian concept of Optimum Currency Area (Mundell (1961)) and therefore attempts to detect and assess the extent of asymmetric shocks between European countries in order to evaluate the sustainability of the future EMU (for instance, De Grauwe et al. (1993), Eichengreen (1992)). Their general conclusion is that, as a whole, Europe can probably not be considered as an OCA due to the presence of uncorrelated country specific demand and supply shocks combined with a labor force which is not sufficiently mobile to cope with such asymmetries. From an economic policy point of view, such a state of facts probably requires to set up some sort of insurance mechanisms through which the risks of temporary economic slow down could be pooled among European countries.

This however leaves open the question of how countries which differ in their fundamental structures might share the benefits or the costs associated to monetary policy coordination. The literature on strategic policy interactions, in which the scope for economic policy coordination hinges on the existence of externalities affecting the policy making of the partners, seems from this point of view a convenient framework. And if few comments have been produced in this sense, it may be due to the fact that most of these models assume perfect symmetry between countries and conclude to a systematic benefical effect of coordination (Currie (1993)).

The aim of this paper is to discuss the issue of monetary policy coordination in a framework where partners differ not because of idiosyncratic shocks but because of structural asymmetries affecting the conduct of national economic policies. These could be the results of, for instance, goods or labor market institutions pecularities (like the extent of nominal rigidities), industrial specialization patterns or national preferences in terms of economic priorities. In the present analysis, asymmetries are introduced at the

[1] See, for instance, Bean (1992) or Eichengreen (1991), for an overview of the question.

level of country size (following Casella (1992) and Martin (1994) who discuss the role played by this factor on monetary policy coordination outcomes) or equivalently at the level of factor productivity.

Moreover, this paper considers the effects of the change from an uncoordinated to a coordinated regime on agents' behavior and interactions. In particular, we envisage the possibility of a counterproductive coordination of monetary policy as central banks' cooperation reinforces their credibility problem vis-à-vis the private sector (Rogoff (1985)). The latter indeed arises in the presence of nominal rigidities as central banks try to exploit the possibility of surprise monetary expansion to reach a target in term of activity level. In this framework, we discuss the conditions under which coordination is feasable (i.e. productive for all partners) and examine the repartition of the possible gains between the members of the agreement according to their characteristics.

The main result of the paper is that the gains from cooperation *reduce* with the size of the economy and eventually turn into losses in terms of the policy makers' objectives. When considering the interactions of the central banks and the private sector, monetary policy coordination implies a cost under the form of an increased inflation bias for all the partners since, as mentioned above, it exacerbates the credibility problem of monetary authorities. It also entails the positive effect of increasing the ability to stabilize inflation around its mean market-determined value, an objective which is assumed to be pursued by the central banks. Wether a country will participate to the currency union or not therefore reflects a balance between these two opposing forces. In coherence with Rogoff (1985), the inflation bias is shown to be higher for large countries. Indeed, a surprise monetary expansion implies a real exchange rate depreciation which reduces the incentive of the central bank to inflate. This adverse terms of trade change is of course more important for a small (open) economy for which a large proportion of goods must be imported and for which therefore the cost for the central bank to manipulate the monetary instrument is likely to be high. Consequently, the smaller the country, the lower its inflation bias and the larger the scope for exchanging a somewhat higher inflation bias against stabilization ability through coordination of monetary policies with potential partners.

Note that empirical analysis (Romer (1993), Lane (1994), Rogoff (1995)) in general support a *negative* link between inflation rates and both the GDP level and the degree of openness to trade. The former observation is related to the fact that large countries are likely to be able to influence their terms of trade which would make expansionnary monetary policy less attractive. The latter on the contrary rests on the fact that for a country with a small degree of openness to trade, domestic consumption is largely based on domestic products which entails smaller short-run inflation costs associated to a monetary expansion. The present framework, which is based on standard monopolistic competition models (Krugman (1980)) in which producers' market power is independent of economic size, therefore leaves aside the first aspect of country size but rather tends to identify small countries with open economies. In this sense, the model developed hereafter is consistent with the empirical findings mentioned above.

One conclusion we draw from this analysis is that the chances of finding a mutually benefical coordination arrangement may be higher if countries are not too different in size (or in factor productivity). In this perspective, the coordination of national monetary policies which will take place under EMU between countries presenting large structural differences might be a source of tension among the partners for which the adoption of simple convergence rules or of insurance schemes constitutes no remedy.

The paper is organized as follows: section 2 developes a model which builts on Obstfeld and Rogoff (1995) and allows to conveniently describe the welfare effects of monetary policy. Section 3 introduces the objective function of monetary authorities and solves the game which takes place between the central bank and the private sector. Section 4 then derives both the cooperative and non-cooperative international equilibria and discusses the conditions under which a productive coordination of monetary policy emerges. Finally, section 5 concludes.

2 The model

In this section, we present an integrative model on which the discussion concerning the coordination of monetary policies will be based. The framework is an extension of Obstfeld and Rogoff (1995) who propose a convenient framework to discuss both credibility and coordination issues. We first develope the model under the general hypothesis of price flexibility and characterize the steady-state long-run equilibrium. We then examine the deviations around the steady-state under the assumption of short-run price rigidity.

2.1 Preferences and technology

We consider a world composed of two countries (home and foreign) inhabited by a continuum of identical infinitely-lived consumers-producers indexed by $i \in [0,1]$. The interval $[0,n]$ represents home agents while the rest $(n,1]$ are foreign residents. Each of them produces a single differentiated tradable good and we assume the tradable sector to be characterized by monopolistic competition. In each country, there is also a non-tradable good (Z) whose production will be considered exogenous. The non-tradable sector is indeed assumed perfectly competitive and the price of non-tradables will always be fully flexible which isolates the production side of this sector from monetary policy. The simplest formalization is therefore to consider that each agent is endowed with one unit of non-tradable in each period.

Agents have identical preferences all over the world which are defined on the consumption of tradable, non-tradable and on work effort:

$$U_{i0} = \sum_{t=0}^{\infty} \beta^t \left[\gamma \, ln(C_{it}) + (1-\gamma) \, ln(Z_{it}) - \frac{k}{2} \, y_t(i)^2\right] \tag{1}$$

where β is the discount factor; C_{it} is a composite tradable goods basket; Z_{it} is consumption of the non-tradable good; $y_t(i)$ is the tradable production of producer i and k is a parameter inversely related to labor productivity. At this stage, asymmetry is introduced in the model as we allow for international factor productivity differences, i.e., for parameter k to be country specific (foreign variables will be indexed by an asterisk).

The tradable consumption index is defined as:

$$C_{it} = \left[\int_0^1 c_{it}(j)^{\frac{\theta-1}{\theta}} dj\right]^{\frac{\theta}{\theta-1}}$$

where $\theta > 1$ and $c_{it}(j)$ is the consumption of differentiated good j by consumer i.

Money is introduced in the model so that the welfare analysis of monetary policy remains as simple as possible. We therefore adopt a fisher identity cash constraint which requires current purchases to be realized with cash[2] and that domestic goods must be purchased with domestic currency. Domestic agents therefore face the following cash constraints:

$$\begin{aligned} M_{it} &\geq \int_0^n p_t(j)c_{it}(j)dj + p_z Z_{it} \\ M_{it}^* &\geq \int_n^1 p_t^*(j)c_{it}(j)dj \end{aligned} \tag{2}$$

where M_{it} and M_{it}^* are the money stocks held by the agent for transactions respectively in domestic and foreign currency, p_z is the price of the domestic non-tradable good and P_t is the home currency utility based tradables price index defined as:

$$P_t = [\int_0^1 p_t(i)^{(1-\theta)}di]^{\frac{1}{1-\theta}} = [\int_0^n p_t(i)^{(1-\theta)}di + \int_n^1 E_t p_t^*(i)^{(1-\theta)}di]^{\frac{1}{1-\theta}}$$

where $p_t(i)$ ($p_t^*(i)$) is the domestic (foreign) currency price set for date t by producer i and E_t is the nominal exchange rate.

We assume no impediments to trade so that the law of one price holds for every individual goods (i.e., $p_t(i) = E p_t^*(i)$). Moreover, since domestic and foreign agents share the same preferences, the composition of their tradable goods basket is identical which implies that the law of one price also holds at the price indices level:

$$P_t = E_t P_t^*$$

where the foreign currency tradable price index is defined in a similar way as the domestic one.

Individuals borrow and lend in world capital market using bonds denominated in terms of tradable. F_{it} is the stock of bonds held by agent i

[2]Rogoff (1995) introduces money through a cash-in-advance representation but solves it as a pure fisherian cash constraint. Since, we do not attempt to introduce intertemporal aspects in the money demand nor wish to consider such things like a possible inflation tax, we select this very simple way to monetarize the model.

entering date $t+1$ while r_t is the real interest rate earned between periods t and $t+1$. The individual intertemporal budget constraint then writes:

$$P_t F_{it} + P_t C_{it} + p_{zt} Z_{it} \leq P_t \left(1 + r_{it-1}\right) F_{t-1} + p_t(i) y_t(i) + p_{zt} \tag{3}$$

Given the utility function, the consumption of a particular variety j by a domestic consumer i is:

$$c_{it}(j) = (\frac{p_t(j)}{P_t})^{-\theta} C_{it} \tag{4}$$

As usual, in this Dixit-Spencer-Stiglitz framework, the elasticity of substiution between varieties (θ) also ends up to be the individual demand price elasticity as the demand schedule faced by a representative producer is:

$$c_t(j) = (\frac{p_t(j)}{P_t})^{-\theta} C_{wt}$$

C_{wt} is the world demand for tradable goods.

Agents therefore maximize their utility under the constraints (2-3-4) and the resulting first order conditions are:

$$\begin{aligned}
Z_{it+1} &= \beta(1+r_t)\, Z_{it} \frac{P_{t+1}}{p_{zt+1}} \frac{p_{zt}}{P_t} && (5)\\
C_{it+1} &= \beta(1+r_t)\, C_{it} && (6)\\
C_{it} &= \frac{\gamma}{1-\gamma} \frac{p_{zt}}{P_t} Z_{it} && (7)\\
y_t(i)^{\frac{\theta+1}{\theta}} &= \frac{\theta-1}{\theta k} \frac{\gamma}{C_{it}} C_{wt}^{\frac{1}{\theta}} && (8)
\end{aligned}$$

The same set of first order conditions apply to the foreign representative agent, the only parameter differing from those appearing in the domestic consumer's problem being the one related to factor productivity (k^*).

2.2 Steady-state and flexible price equilibrium

In steady-state, all exogenous variables are constant and the Euler equations on consumption yield the standard condition on the world interest rate:

$$r = \frac{1-\beta}{\beta}$$

Producers in a country are identical and therefore set the same price and output level. Let us denote the price of a typical home variety by p and the foreign currency price of a foreign variety by p^* while y and y^* are the corresponding output levels.

For the sake of simplicity, we consider the particular steady-state for which the stock of net foreign asset is zero in both country (i.e., $F = F^* = 0$). By the intertemporal budget constraint, the country's per capita steady-state consumption of tradable then equals its per capita tradable output:

$$C = \frac{py}{P}$$

$$C^* = \frac{p^* y^*}{P^*}$$

This allow to derive a closed-form solution for the steady-state whose main features are the following:

$$y = [\gamma \frac{\theta - 1}{\theta k}]^{\frac{1}{2}} \tag{9}$$

$$y^* = [\gamma \frac{\theta - 1}{\theta k^*}]^{\frac{1}{2}} \tag{10}$$

$$\frac{C^*}{C} = [\frac{k}{k^*}]^{\frac{\theta-1}{2\theta}} \equiv \chi \tag{11}$$

Note that, consistently with monopolistic competition, the producer's market power affects the output level which is inferior to its competitive level.

At equilibrium, the cash constraint implies that, for each country, the per capita money holding equals per capita local production of both tradable and non-tradable , i.e.:

$$M = p_z + p\,y = p_z + P\,C \tag{12}$$

$$M^* = p_z^* + p^*\,y^* = p_z^* + P^*\,C^* \tag{13}$$

The price of tradables and non-tradables are then found by use of the first order conditions and by considering now M and M^* as the per capita domestic and foreign money supplies. One easily checks that in this flexible price context, the usual neutrality of money holds as:

$$p_z = (1-\gamma)M \tag{14}$$

$$p_z^* = (1-\gamma)M^* \tag{15}$$

$$p = \frac{\gamma\,M}{y} \tag{16}$$

$$p^* = \frac{\gamma\,M^*}{y^*} \tag{17}$$

2.3 Sticky Prices and Monetary Policy

We can now describe the short-run behavior of the model to monetary shocks. To this end, we first assume the existence of nominal rigidities under the form of predetermined tradable output prices. Individual producers are supposed to fix their price one period in advance so that prices can only be fully adjusted after one period. This price stickiness assumption can be justified in many ways in the case of imperfect competition, the most standard interpretation being one based on the existence of menu costs (see, for instance, Akerlof and Yellen (1985)). We also introduce uncertainty by considering stochastic supply shocks affecting factor productivity. These shocks are assumed perfectly symmetric from one country to the other so that we remain out of the typical OCA literature's framework which bases its comments on monetary policy coordination on the existence of asymmetric disturbances.

Formally, we define the parameter related to productivity as:

$$k = \bar{k}(1+\varepsilon)$$

where ε is a serially uncorrelated disturbance term with mean zero and variance σ^2, so that $\bar{k}$ corresponds to the expected value of k. Under the predetermined price assumption, producers must set their price before knowledge both of the current monetary policy implemented by monetary authorities and the realization of the productivity shocks which implies that the tradable domestic and foreign output prices are respectively:

$$p = \frac{\gamma M^e}{\bar{y}} \tag{18}$$

$$p^* = \frac{\gamma M^{*e}}{\bar{y}^*} \tag{19}$$

where M^e and M^{*e} are the expected per capita supply of domestic and foreign currency; $\bar{y}$ and $\bar{y}^*$ are the output levels associated to $\bar{k}$ and $\bar{k}^*$ respectively. When prices are sticky, the short-run output level will be demand determined as long as the marginal cost does not exceed the preset price level. We rule this possibility out by restricting the distributions of k (k^*) so that large shocks for which the sort-run output level would be affected by the realization of the disturbance term have a negligable density. Denoting the short-run percentage change from the original steady-state by hatted variables, we therefore obtain:

$$\hat{y} = \theta\,[\hat{P} - \hat{p}] + \hat{C}_w \tag{20}$$

$$\hat{y}^* = \theta\,[\hat{P}^* - \hat{p}^*] + \hat{C}_w \tag{21}$$

where

$$\hat{P} = \phi\,\hat{p} + (1-\phi)\,(\hat{E} + \hat{p}^*)$$
$$\hat{P}^* = \phi\,(\hat{p} - \hat{E}) + (1-\phi)\,\hat{p}^*$$

$$\hat{p} = \hat{M}^e$$
$$\hat{p}^* = \hat{M^*}^e$$

$$\hat{C}_w = \phi\,\hat{C} + (1-\phi)\,\hat{C}^*$$

$$\phi = \frac{n}{n + (1-n)\chi}$$

ϕ represents the weight of domestic consumption (production) in world consumption (production). In the absence of productivity differentials (i.e. $\chi = 1$), ϕ reduces to $\frac{n}{n+(1-n)}$, emphasizing that, besides the population of the country, the productivity of its factor is another determinant of its economic size. Note finally that consumption based purchasing power parity still holds in the short-run since, by the expressions above, we have $\hat{E} = \hat{P} - \hat{P}^*$.

We can now proceed to the analysis of a permanent domestic monetary expansion by first examining the resulting exchange rate dynamic. Since prices can be adjusted after one period, a steady-state should be reached one period after the monetary shock occurs. The resolution of the model follows Obstfeld and Rogoff (1995) so that we concentrate on the main results while the derivation can be found in the appendix. As usual, the home monetary expansion yields a depreciation of the domestic currency. Under price stickiness however, this yields a current account surplus for the domestic economy which therefore increases its net stock of foreign assets and a fall in the world interest rate. As a consequence, the home monetary expansion has long run effects in the sense of a transfer of wealth from the foreign to the domestic economy which alters the long-run relative consumption path between the two countries. Denoting by dF the increase in the domestic stock of bonds, we obtain the following expressions for the long-run consumption differential:

$$\hat{\hat{C}} - \hat{\hat{C}}^* = \frac{1}{1-\phi} \frac{1+\theta}{2\theta} r \frac{dF}{C} \tag{22}$$

where $\hat{\hat{C}}$ and $\hat{\hat{C}}^*$ are the changes in domestic and foreign consumption of tradable from one steady-state to the other. Moreover, by substracting the log-linearized form of domestic and foreign Euler equations (6), we obtain:

$$\hat{\hat{C}} - \hat{\hat{C}}^* = \hat{C} - \hat{C}^* \tag{23}$$

As underlined by Obstfeld and Rogoff (1995), since interest rate affects domestic and foreign consumption growth in the same manner, changes in the relative short and long-run consumption are identical.

The short-run current account (which is equivalent to dF as the initial steady-state is characterized by zero initial stock of foreign bonds) corresponds to the difference between real (consumption based) production and consumption of tradable. When expressed in terms of relative growth in the variables, this writes:

$$\frac{dF}{C} = (1-\phi) \cdot [(\hat{y} - \hat{y}^*) - (\hat{C} - \hat{C}^*) + (\hat{p} - \hat{p}^*) - \hat{E}] \tag{24}$$

In this two countries world, the domestic current account surplus corresponds to a foreign deficit which can only emerge if the change in domestic consumption is smaller than that of foreign consumption or if the change in domestic production exceeds that of foreign production. Using the three preceding equations, we then obtain the relationship between the exchange rate change and the relative consumption growth, i.e. the extent of currency depreciation necessary to obtain the home output increase compatible with the rise in relative home consumption:

$$\hat{\hat{C}} - \hat{\hat{C}}^{*} = \Delta[\hat{E} - (\hat{p} - \hat{p}^{*})] \tag{25}$$

with $\Delta = \frac{r(\theta^2-1)}{2\theta+r(\theta+1)}$.

Finally, by log-linearizing and substracting the domestic and foreign money market equilibrium conditions (12-13), we have:

$$\hat{M} - \hat{M}^{*} = (1-\gamma)(\hat{p}_z - \hat{p}_z^{*}) + \gamma[(\hat{p} - \hat{p}^{*}) + (\hat{y} - \hat{y}^{*})] \tag{26}$$

while a similar transformation of the first order condition (7) and of its foreign counterpart yields:

$$\hat{p}_z - \hat{p}_z^{*} = (\hat{C} - \hat{C}^{*}) + \hat{E} \tag{27}$$

Combining these equations, we can now express the variation in the exchange rate as a function of relative money injection:

$$\hat{E} = \frac{(\hat{M} - \hat{M}^{*}) + (\omega + \xi - 1)(\hat{M}^{e} - \hat{M}^{*e})}{\omega + \xi} \tag{28}$$

where $\omega = (1-\gamma)\,\Delta$ and $\xi = 1 - \gamma(1-\theta)$. Note that, if agents correctly anticipate the monetary expansions (i.e., $\hat{M}^{e} = \hat{M}$ and $\hat{M}^{*e} = \hat{M}^{*}$), we have the conventional exchange rate dynamic where $\hat{E} = \hat{M} - \hat{M}^{*}$.

The next step consists in solving the model for $\hat{r}$ and $\hat{C}_w$. To this end, let us define "world" variables as the weighted sum of domestic and foreign corresponding variables, the weights being the relative size of the economies. By the Euler equations, we then have:

$$\hat{C}_w = \phi\,\hat{C} + (1-\phi)\,\hat{C}^{*} = -(1-\beta)\hat{r}$$

and, by the log-linear form of the money market equilibrium conditions:

$$\hat{M}_w = (1-\gamma)\hat{p}_{zw} + \gamma(1-\theta)\hat{p}_w + \gamma\theta\hat{P}_w + \gamma\hat{C}_w$$

One easily checks that, by the the definition of the tradable price indices, $\hat{P}_w = \hat{p}_w$. Moreover, by the first order condition (7):

$$\hat{C}_w = \phi(\hat{p}_z - \hat{P}) + (1-\phi)(\hat{p}_z^* - \hat{P}^*) = \hat{p}_{zw} + \hat{P}_w$$

Injecting this in the $\hat{M}_w$ expression, finally yields the following solution:

$$\hat{C}_w = \hat{M}_w - \hat{M^e}_w \qquad (29)$$

$$\hat{r} = \frac{-1}{1-\beta}(\hat{M}_w - \hat{M^e}_w) \qquad (30)$$

We can now examine the welfare effects of domestic and foreign monetary injections. The key feature we want to focus on is of course the international transmission mechanism by which the monetary shocks occuring in one country affects the partner's welfare. The existence of such externality is indeed at the root of a possible welfare enhancing coordination of monetary policies. Anticipating on the next section in which the choices of the central bank are endogenized, we analyse the effect of a monetary expansion as if it were implemented after the realization of the current disturbance term applied to factor productivity but based on the expected values of future supply shocks. This is indeed the timing of decision which will be assumed while computing the optimal strategy of the national monetary authority. The transposition to the foreign economy being trivial, we restrict the developements to the domestic economy. Let us denote by dU, the variation in the individual utilility level following a change in the money supply. By the utility function (1), we have:

$$dU = \gamma\hat{C} - k\hat{y}\bar{y}^2 + \frac{\beta}{1-\beta}[\gamma\hat{\bar{C}} - \bar{k}\hat{\bar{y}}\bar{y}^2]$$

Using the definition and the solution displayed above for $\hat{C}_w$, we can solve for the relevant variables and obtain:

$$\hat{C} = (1-\phi)\Delta\,[\hat{E} - (\hat{p} - \hat{p}^*)] + \hat{C}_w$$

$$\hat{\bar{C}} = (1-\phi)\Delta\,[\hat{E} - (\hat{p} - \hat{p}^*)]$$

$$\hat{y} = (1-\phi)\theta\,[\hat{E} - (\hat{p} - \hat{p}^*)] + \hat{C}_w$$

$$\hat{\bar{y}} = \frac{-\theta}{\theta+1}\hat{\bar{C}}$$

the last expression making use of the log-linear differentiation of the first order condition (8) and of its foreign counterpart.

The change in the individual utility level as a function of the domestic and foreign money injections is then written as:

$$dU = [\frac{\gamma}{\theta}(1-\rho)](\hat{M}_w - \hat{M}^e{}_w) - [\frac{\rho\gamma(1-\phi)}{\omega+\xi}][(\hat{M} - \hat{M}^* - (\hat{M}^e - \hat{M}^{*e})] \quad (31)$$

where $\rho = \varepsilon(\theta - 1)$.

Let us first examine the deterministic part of this expresion, i.e. $Ed(U)$:

$$E(dU) = \frac{\gamma}{\theta}(\hat{M}_w - \hat{M}^e{}_w) = \frac{\gamma}{\theta}\hat{C}_w \quad (32)$$

which is a simplified version of the result obtained in Obstfeld and Rogoff (1995)[3]. By inspection of (32), one first easily checks that the ability of increasing welfare by use of an active monetary policy is an increasing function of the country size. This simply reflects that the efficiency of monetary policy is related to the existence of nominal rigidities. For an open economy, the price of foreign goods varies even in the context of price stickiness because of the exchange rate change. Therefore, for a small country, i.e., one relying to a large extent on imports, the proportion of goods whose price is fixed in the short-run is rather small and its monetary policy is ineffective. Second, as expected in such a framework, only unanticipated changes in money supply are able to impact on national welfare. This feature is at the root of the credibility problem which emerges when the monetary policy is endogenously determined. Finally, note that the domestic utility level is positively affected by unexpected changes in foreign money supply which is explained by the fact that, in terms of utility, expenditure-switching effects are of second order so that the first order expenditure-increasing effect systematically dominates. This externality naturaly opens the scope for a welfare improving monetary policy coordination.

Finally, turning to the stochastic part of (31), we easily check that a positive realization of the disturbance term reduces the marginal utility of the monetary expansion. This indeed corresponds to a lower factor productivity

[3]Their solution is indeed complicated by the use of a money-in-the-utility function specification which proved untractable for a coordination analysis.

or equivalently to a larger work effort content in tradable production. The distance between the market determined value and the competitive output level is therefore smaller which therefore reduces the incentive to use monetary policy as a welfare improving instrument.

3 The game between central bank and the private sector

We now turn to the analysis of the monetary authoritiy choice and the strategic interactions between private agents and the central bank. The usual assumption in the literature is that central banks pursue a double objective of stabilizing both the activity (or employment) level and inflation rate around given targets. In the present framework, the intervention of the monetary authority hinges on the presence of imperfect competition as central bankers attempt to increase activity to its competitive level. From this point of view, there is no concern about stabilizing economic activity since this is not incorporated in the preferences of private agents. Monetary policy is only able to increase the activity level by means of surprise inflation which, as in the standard Barro-Gordon (1983) framework, leads to a credibility problem when private agents anticipate the moves of the central bank and preset their prices accordingly.

Following Rogoff (1995), we analyse a one shot game time consistent equilibrium in which the central bank sets its monetary policy so as to maximise an objective function whose components are individual utility and inflation. Central banks' preferences are assumed symmetric so that we focus on the domestic policy outcome, the transposition to the foreign economy being straightforward.

$$O = U - \frac{\psi}{2}\hat{P}_c^2 \tag{33}$$

ψ is the weight associated to the inflation target in the central bank's objective function.

Inflation ($\hat{P}_c$) is a weighted average of the price variation in the traded and non-traded sectors, the weights being the respective proportion of the two types of good in overall expenditure.

$$\begin{aligned}\hat{P}_c &= (1-\gamma)\,\hat{p}_z + \gamma\hat{P} \\ &= \alpha_0\,\hat{M} + (1-\alpha_0)\,\hat{M}^e + \alpha_1\,(\hat{M}^* - \hat{M}^{e*})\end{aligned} \tag{34}$$

where

$$\begin{aligned}\alpha_0 &= \phi(1-\gamma) + (1-\phi)\,\frac{\omega+1}{\omega+\xi} \\ \alpha_1 &= (1-\phi)(1-\gamma) - (1-\phi)\,\frac{\omega+1}{\omega+\xi}\end{aligned}$$

As underlined by Rogoff (1995), this formulation remains quite unsatisfactory since it is no less ad hoc than the usual Barro-Gordon framework as far as the inclusion of inflation is concerned. We nevertheless think that the objective of price stabilization assumed here is empirically relevant as most industrialized countries' governments explicitely appoint their central bank with the (exclusive) mission of price control.

The sequence of the game is the following: once tradable goods prices are set and the realization of the current supply shock is known, monetary authority chooses the money supply or equivalently sets the optimal inflation rate so as to maximise the objective function (33). In order to derive the optimal behavior of the central bank, we make use of the log-linearized approximation of the model derived in the preceding section where $\hat{M} = \frac{M}{M_0} - 1$ and $dU = U - U_0$. We then have:

$$\frac{\partial O}{\partial M} = \frac{\partial U}{\partial M} - \frac{\psi}{2}\,\frac{\partial \hat{P}_c^2}{\partial M} = \frac{1}{M_0}\,[\frac{\partial dU}{\partial \hat{M}} - \psi\,P_c\,\frac{\partial \hat{P}_c}{\partial \hat{M}}] = 0$$

and the optimal monetary expansion writes:

$$\hat{M} = \frac{1}{\alpha_0}[\frac{\gamma\phi(1-\rho)}{\psi\alpha_0\theta} - \frac{\gamma\rho(1-\phi)}{\psi\alpha_0(\omega+\xi)}] - \frac{\alpha_1\,(\hat{M}^* - \hat{M}^{e*}) + (1-\alpha_0)\,\hat{M}^e}{\alpha_0} \tag{35}$$

The same kind of conditions apply for the foreign economy (ϕ is there just replaced by $1-\phi$).

Private agents form their anticipations according to the government's reaction function (35). Note that, as producers set their price a period in advance, the monetary policy adopted by the central bank is stochastic from their point of view. The realization of the disturbance term indeed affects the marginal utility of a monetary expansion and the central bank's move is in turn contingent to the current outcome of the supply shock. The condition for a time consistent equilibrium is therefore $\hat{M}^e = E[\hat{M}]$ and similarly for the foreign agents, $\hat{M}^{e*} = E[\hat{M}^*]$. The time consistent equilibrium domestic and foreign inflation rates are then:

$$\hat{P}_c = \frac{\gamma\phi(1-\rho)}{\psi\alpha_0\theta} - \frac{\gamma\rho(1-\phi)}{\psi\alpha_0(\omega+\xi)} \tag{36}$$

$$\hat{P}_c^* = \frac{\gamma(1-\phi)(1-\rho)}{\psi\alpha_0^*\theta} - \frac{\gamma\rho\phi}{\psi\alpha_0^*(\omega+\xi)} \tag{37}$$

In coherence with Romer (1993) or Rogoff (1995), one easily checks that the inflation bias proves to be higher for large countries ($\frac{\partial E[\hat{P}_c]}{\partial\phi} \geq 0$). A surprise monetary expansion indeed implies a real exchange rate depreciation which constitutes a built-in-check mechanism. This adverse terms of trade change is reflected to a larger extent in the consumption price index of a small (open) economy whom a large proportion of goods must be imported and for which therefore the incentive of the central bank to manipulate the monetary instrument is lower. Consequently, the smaller the country, the lower its inflation bias. Moreover, rates of inflation are inversely related to the weight put on inflation stabilisation and positively depend on the share of the monopolistically-produced traded good in overall expenditure. Finally, the more competitive the economy (high value of θ), the lower inflation at equilibrium.

4 Coordination

We now consider two different regimes, one in which domestic and foreign central banks set their monetary policy under a non-cooperative Nash game and one in which monetary policies are coordinated. The coordination scheme is that of a currency union in which a common central bank is substituted to the national ones and sets the optimal monetary policy for the two countries as a whole.

4.1 Cooperative vs non-cooperative regimes

The non-cooperative Nash equilibrium is straightforward to obtain if expressed in terms of the resulting domestic and foreign inflation rates. As it appears in equations (36-37), the optimal national inflation rates are independent of the other country's monetary policy. It is rather the magnitude of the money injection needed to reach this inflation target which adjusts to take into account the foreign monetary policy. The comparison of the two regimes only requires to deal with utility levels and inflation rates so that (36-37) are relevant to characterize the non-cooperative regime.

Turning to the cooperative equilibrium, the scheme of a monetary union de facto implies $\hat{M} = \hat{M}^*$ or equivalently that the coordination takes the form of a fixed exchange rate so that $\hat{E} = 0$.

The common central bank's objective function is a weighted average of the objective function of each country, but in the present framework, the weights prove irrelevant as welfare changes are independent from the localization of money injections. This would no longer be the case however, if countries differed in their relative inflation aversion ($\psi \neq \psi^*$) or in their specific impact of monetary change on utility ($dU \neq dU^*$)[4]. We therefore have:

$$O^c = \pi[U - \frac{\psi}{2}\hat{P}_c^2] + (1-\pi)[U^* - \frac{\psi}{2}\hat{P}_c^2] \tag{38}$$

where c indexed variables refer to the cooperative regime.

In this framework where $\hat{M} = \hat{M}^* = \hat{M}_w$, the change in the individual utility level as a function of the money injections (31) reduces to:

$$dU^c = \frac{\gamma(1-\rho)}{\theta}(\hat{M} - \hat{M}^e) \tag{39}$$

The common time consistent inflation rate is then obtained by maximizing O^c under the constraints (34) and (39):

$$\hat{P}_c^c = \frac{\gamma(1-\rho)}{\psi(1-\gamma)\theta} \tag{40}$$

[4]This last possibility is ruled out by our choice of a multiplicative supply shock affecting labor productivity.

4.2 Comparison of the equilibria

We can now compare the characteristics of the equilibrium inflation rates in the cooperative and non-cooperative regimes. It is straightforward to show that the expected inflation rate is always higher in the cooperative than in the Nash regime as the coordination of monetary policy implies a higher inflation bias which is the finding of Rogoff (1985). Indeed:

$$E[\hat{P}_c^c] = \frac{\gamma}{(1-\gamma)\theta} > \frac{\gamma\phi}{\psi\alpha_0\theta} = E[\hat{P}_c^n]$$

Once again, the reason lies in the fact that in the absence of exchange rate change, the built-in check mechanism which reduces the incentive of the central bank to inflate has disappeared. On the contrary, the effect of coordination of monetary policies on the stabilization objective is ambiguous. Examining the variance of the equilibrium inflation rate, we have:

$$VAR[\hat{P}_c^c] = \frac{\gamma^2}{\psi^2(1-\gamma)^2\theta^2}\,\sigma^2\,(\theta-1)^2 < \frac{\gamma^2}{\psi^2\alpha_0^2}[1 + \frac{\phi}{\theta} + \frac{1-\phi}{\omega+\xi}]^2\,\sigma^2\,(\theta-1)^2 = VAR[\hat{P}_c^n]$$

iff

$$(1-\gamma)\theta > \omega + 1 \qquad \text{i.e.} \qquad \gamma \leq \frac{2\theta\,(\theta-1)}{r+\theta\,(2\theta+r)} \tag{41}$$

In interpreting this condition, one should focus on the effect of the share of the tradable in consumption (γ). The inflation index (34) is a weighted average of the variation in the price of the non-tradable and in the tradable price index. It is easy to show that, in the Nash regime, the price of non-tradable is less sensitive to a change in the money supply than in the cooperative regime. This can be intuitively explained by remembering that the equilibrium condition on the money market requires the effect of a monetary shock to be absorbed by changes in both the price of non-tradable and the production level of tradable. In the non-cooperative regime, because of the beggar-thy-neighbour feature of an expansionary monetary policy, the latter effect is larger than in the cooperative one. Consequently, going from the non-cooperative to the cooperative regime, the extent to which monetary shocks are reflected in the consumption price index is lowered as exchange rate variations are eliminated but increases because of the higher sensitivity of the price of non-tradables. The variance of inflation is therefore more or less important from one regime to the other depending on the relative weight of tradable in overall expenditure.[5]

4.3 Welfare improving coordination

It immediately follows that a country will envisage cooperation if and only if its ability to stabilize inflation around its mean market-determined value (which is inversely related to the inflation rate's variance) is higher in the cooperative than in the Nash regime in order to compensate for the increase in the inflation bias which arises under monetary policy coordination. This implies that if condition (41) is not fulfilled, coordination appears to be always counter-productive in which case a currency union obviously proves irrelevant. We therefore proceed the analysis assuming that coordination can be productive i.e. $(1-\gamma)\theta > \omega + 1$.

Contemplating the prospect of entering a currency union, a country will engage in a cooperative agreement only if coordination allows to reach a higher expected value of the policy makers' objective function, i.e. if $E[O^c] > E[O^n]$. As we now show, this decision depends on three particular parameters which are the proportion of tradable in consumption (γ), the size of the economy (ϕ) and the variance of the variable related to the productivity shock, $S^2 = VAR(\rho) = \sigma^2(\theta-1)^2$. Let us first compute the gain (loss) associated to coordination, $G = E[O^c] - E[O^n]$. This function writes[6]:

$$\begin{aligned} G &= \frac{\psi}{2}\{[\frac{\gamma}{\psi\alpha_0}]^2[\frac{\phi}{\theta}+\frac{(1-\phi)}{(\omega+\xi)}]^2 S^2 \\ &- [\frac{\gamma}{\psi(1-\gamma)\theta}]^2 S^2 - [\frac{\gamma\phi}{\psi\alpha_0\theta}]^2 + [\frac{\gamma}{\psi(1-\gamma)\theta}]^2\} \end{aligned} \tag{42}$$

For each economic size, we can compute the variance level (S_0^2) for which the gain of coordination is zero, in which case the country is indifferent

[5]Note that in the absence of non-tradables ($\gamma = 1$), the variance of the consumer price index is always higher in the cooperative regime which is consistent with Rogoff (1985).

[6]This has been obtained using the fact that in both regimes the expected individual utility level at equilibrium are identical.

between one regime or the other:

$$S_0^2 = \frac{(\omega+1)[2\phi(\omega+\xi)(1-\gamma)+(1-\phi)(\omega+1)]}{[\theta(1-\gamma)-(\omega+1)]\,[2\phi(\omega+\xi)(1-\gamma)+(1-\phi)\theta(1-\gamma)+(1-\phi)(\omega+1)]} \quad (43)$$

Importantly, this relationship exhibits a positive link between the benchmark variance level S_0^2 and the country size. This in fact follows from the quadratic form of the central bank's objective function relative to inflation which implies a rising marginal loss with respect to the expected inflation rate and a constant marginal loss with respect to its variance. As we have shown, the expected inflation rate at equilibrium is larger, the larger the country. On the contrary, the argument developed above to state that the variance of inflation is smaller in the cooperative regime generalizes such that it also decreases with the country size if condition (41) is respected (one easily checks that $\frac{\partial[VAR[\hat{P}_c]}{\partial\phi} \leq 0$).

Consequently, the larger the country, the larger the increase in price stability necessary to compensate the higher inflation rate resulting from coordination. Since the fall in inflation variance following coordination is positively related to the level of uncertainty on productivity, the larger the country the higher the variance of the supply shock term it requires to enter a coordination regime. A large country has therefore a smaller scope for exchanging a somewhat higher inflation bias against stabilization ability through coordination of monetary policies with potential partners.

The remaining of the argument is conveniently illustrated by a graphic representation. To this end, let us first analyse the shape of the gain function (42) with respect to the country size (ϕ). We must distinguish two different cases. For a value of $S^2 \geq \frac{(\omega+1)}{\theta(1-\gamma)-(\omega+1)}$, function $G(\phi)$ is monotically decreasing and the only root in the interval $[0,1]$ is $\phi = 1$. It is indeed easy to show that in this case, $\frac{\partial G}{\partial \phi} \leq 0$ and $G \geq 0 \;\; \forall\phi \in [0,1]$ and cooperation is therefore always benefical. On the contrary, if $S^2 < \frac{(\omega+1)}{\theta(1-\gamma)-(\omega+1)}$, we have two roots for function $G(\phi)$ in $[0,1]$, one for $\phi = 1$ and another at $\phi = \phi_0$ with $\phi_0 \in [0,1[$.

The only difference between the two countries being the economic size, the locus S_0^{2*} is the exact symmetric of the domestic locus with respect to $1-\phi$. The graph displayed below embodies the common features of both the gain function and the S_0^2 locus, as well as its foreign counterpart

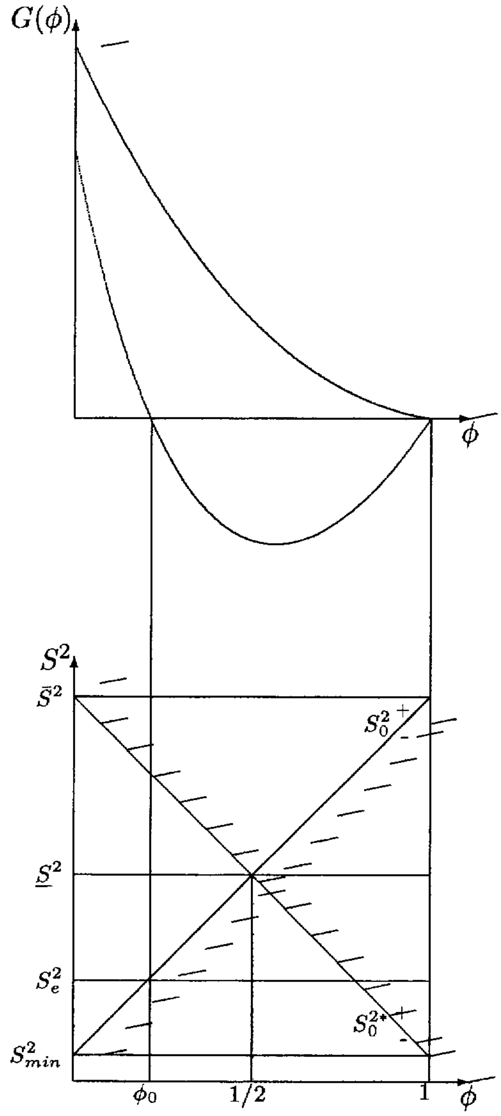

Figure 1: $G(\phi)$ and $S_0^2(\phi)$

(S_0^{2*}) [7]. It can easily be interpreted as follows: for each level of variance, we have a particular position of the gain curve, the higher variance, the higher gain of coordination. It is straightforward, by examining (42), to show that an increase in variance indeed corresponds to an upward shift of $G(\phi)$ (indeed, as long as condition (41) is respected, $\frac{\partial G(\phi)}{\partial S^2} > 0$). This implies that the S_0^2 locus can be interpreted as the minimal variance level for coordination to be productive for each size level. The locus therefore divides the space into two subsets: the zone above the curve corresponds to all combinations of variance and size for which coordination is productive, under to all combinations of the two variables for which gains are turned into losses. For instance, the upper part of the graph reports the G function obtained for a given variance level ($S^2 = S_e^2$) whose two roots are ϕ_0 and 1. For all sizes inferior to ϕ_0, coordination proves productive, for all sizes superior to ϕ_0, it proves counter-productive.

We can now distinguish three key variance levels. $S_{min}^2 = S_0^2(\phi = 0)$ is the minimal level required by an infinitely small country to enter a currency union with an infinitely large partner.

$$S_{min}^2 = \frac{(\omega + 1)^2}{\theta^2 (1-\gamma)^2 - (\omega + 1)^2}$$

$\bar{S}^2$ is the variance level starting from which coordination becomes always benefical whatever the size of the country. It is for this variance level that the G functions start to have an unique root in $[0, 1]$ at $\phi = 1$ and is positive on the whole interval (the case of the upper G curve in the graph above).

$$\bar{S}^2 = \frac{(\omega + 1)}{\theta (1-\gamma) - (\omega + 1)}$$

Finally, we have $\underline{S}^2$ which corresponds to the minimal variance level for two countries of equal size to consider a coordination agreement. This corresponds to $S_0^2(\phi = 1/2)$ which by monotonicity of $S_0^2(\phi)$ is smaller than $\bar{S}^2 = S_0^2(\phi = 1)$.

As a result, one first observes that, for coordination between the two countries conceivable, i.e. to be productive from the point of view of the

[7] The S_0^2 and S_0^{2*} loci are here represented in the special linear case for convenience. Concavity can actually go either way.

two governments, the variance level must be superior to $\bar{S}^2$. If this is not the case, one country automatically suffer from coordination losses whatever the relative size of the partners and therefore has no incentive to participate to a currency union. Second, for variance levels in the interval $[\underline{S}^2, \bar{S}^2]$, coordination is possible but only between partners not too different in sizes, this restriction becoming weaker as the variance increases toward $\bar{S}^2$. For each variance level in this interval, we can indeed determine the relative size range (located between the two S_0^2 and S_0^{2*} loci) out of which one country loses from coordinating its monetary policy with the other. These considerations are the core of the argument which emphasizes the possible difficulty there may be to implement this type of coordination between partners differing in their fundamental characteristics.

Finally, the coordiantion payoffs are unevenly shared between partners differing in their size as the distribution of gains is always at the advantage of the smaller country. Although we only considered here a limited framework with two potential partners, this opens the question of the stability of policy coordination whose benefits are distributed among the members of the agreement according to an asymmetric scheme. In this perspective, a core analysis of an arrangement such as EMU would allow to gauge the probabilty of free-riding or alternatively of the emergence of tensions among the partners engaged in this kind of macroeconomic policy coordination.

5 Conlusion

In this paper, we discussed the question of monetary policy coordination between partners differing not because of uncorrelated idiosyncratic shocks but because of structural asymmetries affecting the conduct of national economic policies. The model on which our argument builts is an actualization of the framework developed in Rogoff (1985) using a micro-funded intertemporal approach in which we allowed for international differrentials at the level of country size and factor productivity.

We therefore reproduced the Rogoff's result that coordination of monetary policy can be counter-productive. Coordination indeed exacerbates the credibility problem of the central bank and therefore induces a higher inflation bias. On the other hand, provided the share of non-tradables in consumption is sufficiently large, coordination also implies an increased ability to stabilize inflation around it's mean market-determined value. The decision to participate to a currency union therefore reflects a balance between these two opposing forces.

The main result of the paper is that the possible gains from cooperation are shown to reduce with the size of the economy and eventually turn into losses. A small (open) economy, for which unilateral money supply growth is rather ineffective in real terms, is indeed more likely to improve its activity/inflation trade-off through coordination of monetary policy than a large country. Consequently, we find that if the variance of supply shocks affecting symmetrically the two economies falls under a certain level, the chances of finding a mutually benefical coordination arrangement may be higher if countries are not too different in size or in productivity.

The model presented here, in which economic size is the main source of asymmetries, is meant to provide an illustration of a more general argument, namely that international differences in the structural factors affecting the relationship between inflation and activity level of an economy could play a role similar to that of asymmetric shocks in the OCA theory by limiting the scope for productive coordination of economic policy.

In this perspective, the effects of the coordination of national monetary policies which will take place under EMU should not only be assesed by examining the likelihood of assymetric shocks in Europe but should also take into account the structural disparities which might exist between European countries. From economic policy point of view, the two approaches are nevertheless not perfect substitutes since the solutions one may adopt to tackle one type of asymmetries are not automatically relevant for the other type. For instance, if some sort of insurance mechanism at the European level seems a reasonable way to cope with the existence of uncorrelated country specific shocks, we think that institutional schemes (like the appropriate design of the European central bank in our example of monetary policy coordination) could be more adequate solutions to asymmetries of the structural type.

Appendix

In this appendix, we solve the model to obtain the long-run response to a permanent monetaryshock from which equations (22) is derived. We proceed by log-linearising the long-run demand, offer, budget constraint and world consumption to get:

$$
\begin{aligned}
\hat{\tilde{y}}_d &= \theta(\hat{\tilde{P}} - \hat{\tilde{p}}) + \hat{\tilde{C}}_w \\
\hat{\tilde{y}}_d^* &= \theta(\hat{\tilde{P}}^* - \hat{\tilde{p}}^*) + \hat{\tilde{C}}_w
\end{aligned}
$$

$$
\begin{aligned}
\hat{\tilde{y}}_t &= \frac{-\theta}{\theta+1}\hat{\tilde{C}}_t + \frac{1}{\theta+1}\hat{\tilde{C}}_w \\
\hat{\tilde{y}}_t^* &= \frac{-\theta}{\theta+1}\hat{\tilde{C}}_t^* + \frac{1}{\theta+1}\hat{\tilde{C}}_w
\end{aligned}
$$

$$
\begin{aligned}
\hat{\tilde{C}}_t &= r\frac{dF}{C} + \hat{\tilde{p}}_t - \hat{\tilde{P}}_t + \hat{\tilde{y}}_t \\
\hat{\tilde{C}}_t^* &= r\frac{-n}{1-n}\frac{dF}{C^*} + \hat{\tilde{p}}_t^* - \hat{\tilde{P}}_t^* + \hat{\tilde{y}}_t^*
\end{aligned}
$$

These two last expressions are obtained by making use of the identity $ndF + (1-n)dF^* = 0$.

$$
\hat{\tilde{C}}_w = \phi\hat{\tilde{C}} + (1-\phi)\hat{\tilde{C}}^*
$$

We can now solve this system of seven equations in the seven unknows $(\hat{\tilde{C}}, \hat{\tilde{C}}^*, \hat{\tilde{y}}, \hat{\tilde{y}}^*, \hat{\tilde{C}}_w, \hat{\tilde{p}}, \hat{\tilde{p}}^*)$ to obtain:

$$
\begin{aligned}
\hat{\tilde{C}} &= \frac{1+\theta}{2\theta}r\frac{dF}{C} \\
\hat{\tilde{C}}^* &= \frac{-n}{1-n}\frac{1}{\chi}\frac{1+\theta}{2\theta}r\frac{dF}{C}
\end{aligned}
$$

It's then easy to check that the substraction of this two expressions leads to equation (22).

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