Monetary policy in heterogeneous currency unions: Reflections based on a micro-founded model of Optimum Currency Areas.

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European University Institute, University of Rome III, and CEPR

Notes developed from the keynote speech delivered during the conference
"Monetary policy implications of Heterogeneity in a Currency Area"
European Central Bank
Frankfurt am Main, 13-14 December 2004

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Abstract

The adoption of a common currency has fostered European economic integration and provided many European countries with an efficient tool to reduce inflation and financial volatility. It is well understood, however, that a single monetary policy also opens a stabilization gap at national level, relative to an ideal benchmark in which output gaps and marginal costs are efficiently stabilized in each region of the monetary union.

Recent monetary theory has stressed efficiency costs of inflation dispersion in the presence of nominal rigidities. In a single currency area, some inflation dispersion will be the unavoidable costs of relative price adjustment across sectors and regions.

In this text, I argue that the same class of models highlighting the costs of inflation dispersion also points to a different cost of inefficient stabilization, consisting of a wedge between average output and its efficient level. The adoption of a single currency does not affect the rate of growth of GDP, but may affect the average level of activity, as a stabilization gap at national level exacerbates monopolistic distortions.

Moreover, convergence in growth rates is not necessarily an indicator that heterogeneity in business cycle is falling. A micro-founded OCA model unveils the possibility that monetary unions be self-validating optimal monetary regimes, whereas economic costs due to heterogeneity persist even if growth rates converge completely after monetary unification.

I conclude with a brief discussion of other dimensions of other possible welfare losses in a monetary union, including inflation dispersion, suboptimal level of investment, market segmentation, and inefficient provision of public goods – which provide interesting and potentially important directions for future research.

1 Introduction

Economic heterogeneity is in many ways a vital sign of growing and healthy economies. By the same token, differences in institutions and policies may reflect diversity in preferences and political orientations across communities in a currency area, consistent with the democratic nature of our societies. Nonetheless, the recent debate on European monetary union has motivated a reconsideration of the question as of whether elements of economic 'heterogeneity' may also matter for the design of efficient stabilization policy. A partial list includes sectoral composition of output, the degree of nominal rigidities across sectors and regions, financial structure and labor market institutions, and the degree of liberalization and deregulation. To what extent should a central bank worry about these elements, beyond monitoring their role in macroeconomic developments? The European Central Bank is by no means the only central bank facing this question – but national differences and the lack of political integration make it more pressing in the euro area than elsewhere.

Looking at the recent literature on the topic, it is fair to say that the scope and importance of policy trade-offs raised by heterogeneity is far from clear. In light of recent advances in monetary and macroeconomic theory, recent contributions have reformulated standard closed-economy monetary models (e.g., Woodford (2003)) by allowing for macroeconomic heterogeneity. Optimal stabilization rules have been characterized in relation to specific cross-border differences in financial structure or nominal rigidities,[1] sometimes yielding articulated policy-oriented suggestions (we should note here that robustness of the policy prescriptions to model mispecification is an important open issue that such exercises should thoroughly discuss).

Underlying these contributions, however, there is a basic issue — an issue which is far from new but has not been systematically reconsidered in light of the new monetary and international economic literature. What is the cost of substituting country-specific optimal monetary policies with a single monetary policy? In this brief text, I will address this gap in the literature. Toward this goal, I will reconsider the 'costs of monetary union' in the framework of a stylized choice-theoretic model — representative of the framework commonly adopted by recent contributions to monetary economics. Focusing on a case in which I can characterize optimal monetary policy in different exchange rate regimes, I will discuss the following question: are there differences in the macroeconomic performance of monetary unions relative to economies with an independent monetary policy, under the maintained assumption that in each of these regimes stabilization policies are optimally conducted? In other words, what are the macroeconomic effects of a single welfare-optimizing monetary policy? What is the magnitude of the welfare costs of deviating from an ideal benchmark of nation-specific optimal monetary policy?

It should be emphasized that in my exercise the cost of a single monetary

[1] For instance, some contributions in the literature have recently explored policy trade-offs due to heterogeneity in the degree of nominal rigidities (see Benigno (2004) among others), and carried out an analysis of optimal policy rules.

policy will be assessed relatively to an ideal state of efficient domestic stabilization. Hence, the exercise will provide an assessment of the potential gains from activating additional instruments of business cycle stabilization at national or union-wide level, including fiscal policy as well as labor and financial policy.

Similar issues are at the core of the traditional Optimum Currency Area (henceforth OCA) theory. But my arguments will be quite different from those pursued by the traditional literature, in that they are rooted in a stylized micro-founded model in which all agents are rational: households maximize expected utility, firms maximize expected profits, monetary authorities maximize national welfare, indexed by the representative household's utility. I will assume that policymakers can credibly commit to rules, and I will characterize optimal policy as optimal rules, rather than discretionary reaction to shocks – as is the case in the Keynesian model underlying the original OCA theory. As is well understood, an important advantage of this approach is the possibility of carrying out welfare analysis using consumers' expected utility as an indicator of national welfare.

I will discuss three main points. First, an important prediction of recent standard monetary models with imperfectly competitive firms and nominal rigidities is that insufficient domestic stabilization will result in higher product prices, lower average consumption and lower average output relative to an efficiently stabilized economy. This 'wedge' in average output and consumption – in level, not in growth rates – has not been sufficiently discussed in the literature, yet it characterizes a large class of models commonly adopted in monetary theory. Since, even when optimally conducted, a single monetary policy implies incomplete stabilization at country level, an output and consumption wedge is a cost from monetary unification, independently of the efficiency and effectiveness of the single monetary authority. Some back of the envelope calculations, however, suggest that the magnitude of welfare loss is contained, consistent with Lucas (1987, 2003).

Second, I will discuss the possibility of self-validating optimal exchange rate regimes. For given fundamentals, a monetary union may be perceived as an optimal arrangement, in the sense that the private sector and the monetary authorities optimally respond to each other's policy, modifying the equilibrium allocation. I will analyze a few properties of self-validating optimal monetary unions (OMU). Relatively to the benchmark of floating exchange rates with optimal monetary rules in place, business cycle convergence will be endogenously higher for any given distribution of fundamentals, raising issues in interpreting output growth correlation within a currency area as an indicator of symmetry in macroeconomic fundamentals. In light of the previous point, the presence of asymmetric shocks will make the macroeconomic allocation differ from the flex-price benchmark in a number of dimensions. In particular, average prices will be too high, output too low. For identical fundamentals welfare could be higher if national output gap and marginal costs could be completely stabilized — as would be the case in a floating regime with optimizing central banks.

Finally, I will reconsider recent literature questioning a basic tenet on the benefit of exchange rate flexibility underlying the traditional OCA theory. This recent literature stresses the possibility of destabilizing exchange rate move-

ments — a view that is at odds with the received wisdom. I will argue that, even if the new view was correct, it would not necessarily provide an argument in favor of monetary union.

I will conclude with a discussion of some extensions of the analysis. In my text, I will build upon recent joint work with Pesenti.

2 Revisiting the foundations of OCA

The seminal contributions to the so-called Optimum Currency Area theory, including Mundell (1961), McKinnon (1963), Kenen (1969), Ingram (1973), focus on the costs of exchange rate inflexibility in the presence of asymmetric, country-specific temporary shocks and (by logical extension) asymmetric short-run response to common temporary and permanent shocks — including unexpected components of monetary policy.

As is well known, the argument is that these asymmetries weaken the case for a common currency, as members of monetary union lose the benefits from

1. monetary autonomy;

2. stabilizing movements of the exchange rate.

The literature stresses that the benefits from (1) and (2) above are low if: prices and wages are sufficiently flexible; fiscal policy effectively stabilizes national economies; consumption risk is sufficiently diversified across borders; international financial markets work smoothly; factors are sufficiently mobile also in the short run and at low costs; there are little asymmetries in shocks and in macroeconomic transmission.

The original contributions to this theory abstract from other potentially sizeable benefits of a monetary union, e.g., benefits from policy delegation, saving on transaction costs, benefits of political integration (reflecting the opinion that this is more likely in the presence of monetary union), and so on. These arguments have played an important role in the debate on EMU. They have also been included in modern textbooks as extensions of OCA beyond the original theoretical boundaries. However, following the original contributions, I will abstract from these issues altogether — being aware that, historically, these benefits from European monetary union may have more than compensated the costs analyzed below.

In my discussion, I will re-visit OCA theory in the framework of a stylized choice theoretical model of currency union. The model in the background of my analysis is fully specified in Corsetti and Pesenti (2002, 2005a, 2005b) – in this text, I will only use a minimal set of analytical expressions referring the reader to these references for details. The analytical framework is a general equilibrium, two-country, choice-theoretic stochastic model with nominal rigidities and imperfect competition in production. Each country (Home and Foreign, denoted by H and F) is perfectly specialized in a single type of tradable goods. Assets markets are incomplete. For simplicity, preferences for consumption are

in log form and additive separable in labor. Also technology is linear in labor. I will focus exclusively on country-specific i.i.d. productivity shocks. While traditional OCA treats stabilization policies as discretionary reactions to shocks, ignoring their effects on private sector expectations, I will follow recent monetary literature and characterize optimal policy rules under the assumption that policymakers can commit to them.

To make my points most clearly, I will first analyze a version of a closed-economy version of the model — i.e., I will treat the Home and Foreign economy as if they were closed to trade in goods and assets. In the next section, I will instead refer to the complete open-economy specification. In both sections, I will assume that firms set the nominal price of their product one period in advance (either their own currency, or in both domestic and foreign currency), and stand ready to meet (domestic and foreign) demand at those prices for one period only. By resorting to this specification of nominal price rigidities, I abstract from macroeconomic and welfare-related issues raised by inflation dispersion. This assumption is quite important. Most recent monetary models place inflation dispersion at the core of welfare analysis of monetary rules. Costs from inflation dispersion create important trade-off facing policymakers in a monetary union, and may potentially be another dimension of the welfare loss from a single monetary policy, relative to what I analyze below. I will discuss inflation dispersion in Section 5.

3 On the costs of loosing monetary autonomy in choice-theoretic models of optimum currency area

3.1 Efficient monetary policy and the costs of insufficient stabilization

My starting point is a discussion of a potentially important welfare dimension of stabilization, which characterizes a large class of recent models in monetary economics, but is somewhat less well-known than other dimensions (e.g., inflation dispersion). As mentioned above, I will proceed in this section as if the Home and Foreign country were two closed economies.

In the Corsetti-Pesenti model, the expression for optimal pricing takes a particularly simple form. Home firms selling in the Home market will optimally set domestic prices $P_{\mathrm{H},t}$ equal to expected marginal costs augmented by a markup (which is a function of the elasticity of substitution across domestically produced varieties of the Home goods, indexed by θ)

$$P_{\mathrm{H}} = \underbrace{\frac{\theta}{\theta - 1}}_{\text{markup}} \cdot \underbrace{[E_{t-1} MC]}_{\text{expected marginal costs}}$$

A similar expression holds for the price of Foreign good preset by Foreign firms in their local market.

Now, let μ denote a synthetic indicator of monetary stance — whatever the instruments used by the central bank. An increase in μ corresponds to Home monetary policy expansion, raising nominal demand. In an equilibrium with a competitive labor market, the nominal wage rate will be proportional to μ_t. Thus, in equilibrium marginal costs can be written as

$$MC = \frac{\overbrace{\mu}^{\text{monetary policy stance}}}{\underbrace{\left(\frac{\mu}{Z}\right)}_{\text{productivity}}}$$

where Z_t is Home (labor) productivity.

It is easy to see that, for a given monetary stance μ_t, a positive productivity shock (an increase in Z_t) lowers ex-post marginal costs. Since prices are preset, firms cannot take advantage of higher productivity to lower prices and raise output. Nominal and real demand are fixed. As a result, the productivity shock opens a positive output gap: employment falls relative to the flex-price allocation. In such circumstances, however, monetary authorities can improve welfare by expanding aggregate demand, closing the output gap at given prices, and stabilizing marginal costs.

In particular, monetary policy can completely stabilize marginal costs vis-a-vis productivity shocks by setting $\mu = Z$. When monetary authorities follow this rule, marginal costs are constant

$$MC = \frac{\mu_{(\mu=Z)}}{Z} = 1$$

so are optimally preset prices. Ex post, the domestic output gap is completely stabilized: demand grows when productivity is high; it contracts when productivity is low. Note that nominal rigidities are not consequential as regards the equilibrium allocation: the equilibrium allocation coincides with the flex-price allocation despite price stickiness. Indeed, it can be shown that, in this model, welfare-optimizing central banks will follow rules implying $\mu = Z$.

However, suppose that stabilization is not complete, say, $\mu = Z^{\xi}$ with $0 < \xi < 1$. It is easy to see that marginal costs will vary stochastically over time. Demand will vary too little relative to productivity and output gaps would not be completely stabilized. Note that $\xi = 0$ corresponds to the case in which monetary policy is not contingent on the state of the economy – consistent with a constant growth rate of money stocks between periods.

Using the above expression, we can derive an important implication of insufficient stabilization. With incomplete stabilization, the expected value of marginal costs is larger than in the case of complete stabilization

$$E_{t-1}\left[\frac{\mu_{(\mu=Z^{\xi})}}{Z}\right] = E_{t-1}\left[Z^{\xi-1}\right] > 1.$$

as a straightforward implication of Jensen's inequality. For any given average monetary stance, the lower the extent of stabilization, the higher the preset product prices.

Intuitively, firms' optimal pricing policy is such that they are always on their supply curve *on average*. But when productivity is low, demand does not fall optimally: in low-productivity states, they over-supply relative to the efficient level. Conversely, when productivity is high, demand does not rise enough: in high productivity states firms under-supply relative to the Pareto optimal allocation. As a result, while employment is on average at its natural rate, average output is not: it will fall short of the efficient level.

Now, in a closed economy net output is equal consumption, i.e. $C = Y$. Hence, average consumption will also be too low relative to the case of full stabilization ($\xi = 1$):

$$E_{t-1}Y = E_{t-1}C = E_{t-1}\frac{\mu}{P} =$$
$$= E_{t-1}\overline{\ell} \cdot \frac{E_{t-1}\left[Z^{\xi}\right]}{E_{t-1}\left[Z^{\xi-1}\right]} < \overline{\ell} \cdot E_{t-1}\left[Z\right]$$

where $\overline{\ell}$ denotes the natural rate of employment.

Suppose for simplicity that Z is lognormally distributed. Then, we can write the loss in expected consumption due to incomplete stabilization as follows

$$\Delta\mathcal{W} = \frac{1}{2}\left(\xi - 1\right)^2 Var_{t-1} \ln Z \tag{1}$$

When $\xi = 1$ the economy is fully stabilized: the variance of the shock does not affect expected utility, and the above expression is identical equal to zero. If $\xi < 1$, instead, expected utility will be decreasing in the variance of the shock.

This property of recent monetary models cannot be overemphasized: with nominal rigidities and monopoly power in production, incomplete stabilization affects average prices in equilibrium. For standard parametrization, given demand, average prices will be too high, average output and consumption of Home goods will be too low relative to the flex-price benchmark.

I should stress here that the growth rate of the economy is not affected: in the long run the economy will expand at the same rate of productivity growth, independently of the monetary regime. Yet, there will be a level gap between average potential and current output, depending on the monetary regime. I should also stress that this gap will not disappear if firms profits are taxed away on average (e.g. Galì (2003)) – to address monopolistic distortions in the economy.

The above argument points to a cost of business cycle which is not widely discussed. Observe the nice parallel between (1) and the welfare costs formula in seminal contribution by Lucas (1987, 2003). While being consistent with Lucas' analysis, in this text the analysis is carried out from a different angle. To appreciate it fully: the argument stresses that, in standard monetary models, the goal of stabilization is not to eliminate consumption variability around a

smooth trend. Rather, the goal of stabilization is to reduce the gap between consumption and its efficient level — which may well be time varying depending on the state of the economy:

$$\widetilde{C} = \overline{\ell} \cdot Z$$

In the model underlying my calculations above, full stabilization completely closes the output gap, ensures that employment is at its natural rate, but lets consumption fluctuate optimally with the state of the economy. Paradoxically, incomplete stabilization makes consumption 'smoother' relative to a flex-price economy, but suboptimally so. In the model above, it is easy to verify that a constant μ (or μ growing at a deterministic rate) will imply that consumption is constant, but at a lower average relative to a perfectly stabilized economy, while at the same time causing excessive volatility of employment.[2]

Clearly, there is a need for empirical evidence on the link between price levels and monetary regimes. We can however perform back of the envelope calculation to verify the order of magnitude of the welfare costs of insufficient stabilization. Let the standard deviation of productivity be 1 percent per period. Moving from no stabilization $\xi = 0$ to full stabilization $\xi = 1$ is worth approximately one half of a hundredth of a percent of consumption per quarter. The order of magnitude of this assessment is fully consistent with Lucas' point on the small costs from busines cycle.

3.2 On the costs of heterogenous monetary union

What are the implications of the above analysis for monetary union? It is well understood that a welfare-optimizing central bank in a monetary union should react to the average cyclical conditions of common currency area. While there could be different views on the weighting scheme used in building area-wide averages, a single (optimal) monetary policy will not be able to stabilize fully output gaps and producers' marginal costs at national level — as crudely captured by the slogan 'one size cannot fit all'. In the framework of the model above, a single monetary policy would correspond to some ξ strictly below one – depending on the weight of the region/country in the union-wide aggregates.

As shown above, a lesson from microfounded models with nominal rigidities and monopolistic power in production is that incomplete stabilization of marginal costs and output gap (i.e., $\xi < 1$) results into optimally preset prices that are on average too high, reducing average consumption and welfare. The magnitude of this welfare loss is however quite small. There are reasons to believe that it will be even smaller in a monetary union (under the maintained assumption that the single monetary authority pursues policies that react to shocks).

First, shocks in the union may be correlated: what counts in the above analysis are country-specific innovations in Z, not its global component. Obviously, the cost of a single currency will be decreasing in the degree of symmetry

[2] Disutility of labor is not ignored in the analysis above. It drops out of the welfare analysis, since in my simple model specification, expected labor effort in equilibrium is independent of the policy regime.

of productivity shocks hitting the different regions of the monetary union. Second, the cost of a single monetary policy will be smaller for countries with a larger weight in the union-wide aggregates used by the central bank to guide its policies. Last, it will be much smaller if the common currency area fosters financial market integration, as part of output risk can be diversified away (to the extent that assets markets provide insurance opportunities to consumers). Recall that in the model above we abstract from portfolio diversification.[3]

The main policy conclusions of the traditional OCA theory are that monetary union challenges domestic policy makers to find alternative instruments of business cycle stabilization, or implement reforms that reduce the magnitude of frictions and distortions creating a stabilization problem. These conclusions are still valid in the above analysis – it is indeed desirable to use additional policy instruments (such as fiscal policy). However, the micro-founded models of currency area suggests a clear parallel between the magnitude of welfare gains from stabilizing the business cycle, and the magnitude of welfare costs due to a single monetary policy. If one is skeptical about the former, he/she must be skeptical about the latter.

It is worth noting, here, that similarly skeptical views of the welfare costs of monetary union had also been expressed by critics of the OCA theory using the same theoretical model underlying the original contributions to this theory, most notably by Willem Buiter (see for instance Buiter (2000)).

4 Optimal Monetary Union (OMU) as a self-validating exchange rate regime

I will now revisit the above argument in a full general equilibrium model of monetary union, in which countries trade with each other. In addition to confirming the findings discussed above, a micro-founded model of OCA yields a new result, pointing to the possibility of optimal monetary union as self-validating monetary and exchange rate regimes.

4.1 Stabilization and import prices

Assume that the two countries in our world economy adopt a floating exchange rate regime. Let $\mathcal{E}$ denote the nominal exchange rate between the Home and the Foreign currency (measured in units of Home currency per unit of Foreign currency). In equilibrium it will depend on Home and Foreign monetary stances

$$\mathcal{E}_t = \mathcal{E}_t \left(\frac{\mu}{\mu^*} \right)$$

[3] One may observe that a single monetary policy in a currency union may also be a source of policy shocks in a specific region, when monetary stance is tightened or loosened in response to average conditions of the economy. In the model above, it turns out that monetary noise – modelled as shocks to μ independent of the state of the economy, has no consequences on expected utility. Insufficient stabilization of domestic productivity shock is all that matters.

where a '*' denotes foreign variables.

As discussed above, nominal rigidities in the domestic market imply that domestic firms optimally preset prices by charging a constant mark-up over expected marginal costs – this will be true both in the Home and in the Foreign country (i.e., the expressions shown in the previous section will still be valid). However, modelling nominal rigidities in the export markets requires some additional assumptions about the elasticity of prices to exchange rate movements. As stressed by the literature, the macroeconomic allocation will depend crucially on these assumptions. Building on my previous work with Paolo Pesenti, I will proceed by positing that export prices can be indexed to exchange rate movements, and the degree of exchange rate pass-through onto import prices in local currency is a choice variable. Let η denote the degree of exchange rate pass-through into the Home prices of Foreign goods. Given η, profit maximizing Foreign firms will set the prices of their goods in domestic currency as follows

$$P_{\mathrm{F},t} = \overbrace{\left[\frac{\theta}{\theta-1} E_{t-1}\left(MC_t^* \cdot \mathcal{E}_t^{1-\eta_t}\right)\right]}^{\text{preset component of import price}} \cdot \overbrace{\left[\mathcal{E}_t^{\eta_t}\right]}^{\text{component that is indexed to the exchange rate}}$$

where MC^* is foreign marginal costs, and the subscript F stands for 'Foreign'.

The literature has discussed in detail the difference between 'Producer Currency Pricing' and 'Local Currency Pricing'. It is easy to verify that the former corresponds to the case $\eta = 1$: by setting $\eta = 1$, Foreign firms choose to preset prices in their own currency, and let the Home currency price of their goods move one to one with the exchange rate:

$$P_{\mathrm{F},t} = \left[\frac{\theta}{\theta-1} E_{t-1}\left(MC_t^*\right)\right] \cdot \mathcal{E}_t$$

In this case, the exchange rate pass-through into import prices is clearly 100 percent.

'Local Currency Pricing' corresponds to $\eta = 0$: by setting $\eta = 0$, Foreign firms choose to preset prices in their own currency for their local market, and in the Home currency for the Home market. The former is analogous to P_{H} above, the latter will be

$$P_{\mathrm{F},t} = \left[\frac{\theta}{\theta-1} E_{t-1}\left(MC_t^* \cdot \mathcal{E}_t\right)\right] \cdot 1$$

Since Foreign goods prices are preset in local currency, exchange rate pass-through is zero.

We stress here a reason to focus on the two cases $\eta = 1$ and $\eta = 0$. Even though intermediate η are possible in our model, in an equilibrium where monetary authorities are welfare maximizing, only these two cases will be optimally selected by domestic and foreign firms.

The literature has pointed out that optimal policy rules vastly differ depending on the degree of pass-through. For instance, suppose that pass-through is complete ($\eta = 1$). In this case, import prices in *foreign* currency are independent

of domestic monetary policy:

$$\frac{P_{\mathrm{F},t}}{\mathcal{E}_t} = \frac{\theta}{\theta - 1} E_{t-1}\left[MC_t^*\right] = \frac{\theta}{\theta - 1} E_{t-1}\left[\frac{\mu^*}{Z^*}\right].$$

In other words, while in each period Home import prices in Home currency will vary one-to-one with the exchange rate, exchange rate movements induced by Home monetary policy will have no impact on their *average* level. This is because Foreign marginal costs are not affected by μ so that, by choosing perfect pass-through, Foreign firms can insulate their expected profits from Home monetary shocks. In such case, Home monetary authorities can optimally focus on stabilizing domestic marginal costs/output gap

$$\mu = Z$$

and let exchange rate movements 'adjust' international prices. The ex-ante level of import prices will only depend on Foreign monetary policy (and supply shocks).

Things are quite different if pass-through is not complete ($\eta < 1$). Average import prices will *also* depend on the distribution of domestic monetary policy. Then, stabilizing *only* domestic marginal costs is not optimal for Home authorities. This is because – for the same reason studied in the previous section – the implied volatility of the exchange rate will translate into average import prices that are suboptimally high (see Corsetti and Pesenti (2005) for details).

Indeed a number of contributions on optimal monetary policy in open economy find that, when nominal rigidities imply incomplete pass-through, optimal monetary policy stabilizes a weighted average of domestic and foreign marginal costs (or output gap), with weights depending on (a) the share of imports in CPI; (b) the degree of pass-through in the economy. In my model with Pesenti, for instance, Home optimal policy rule satisfies:

$$1 = \gamma \frac{MC_t}{E_{t-1}\left(MC_t\right)} + (1-\gamma)(1-\eta_t)\left[\frac{(1-\eta_t)\, MC_t^* \mathcal{E}_t^{1-\eta_t}}{E_{t-1}\left(MC_t^* \mathcal{E}_t^{1-\eta_t}\right)} - 1\right]$$

where η_t indexed the degree of pass-through in the Home market, and γ is the weight of imports in domestic consumption. If $\eta = 1$, the second term on the right-hand side in the above expression disappears, and domestic benevolent policy makers would fully stabilize Home productivity shocks. But with $\eta < 1$, imperfect pass-through due to nominal rigidities in local currency implies that national marginal costs will not be stabilized fully, but only on average. Other things equal, the weight of the second term in the above term is decreasing in γ (the economy is less open) and η (pass-through is higher).

Unless domestic and foreign shocks are perfectly symmetric (i.e. there is only an economy-wide shock), monetary authorities will not fully stabilize marginal costs and output gap in one country. Hence, in general the national allocation will not coincide with the flex-price allocation.

4.2 Firms' optimal pricing policies

The analysis above has shown that optimal monetary policy depends on pass-through. Clearly, *optimal pass-through in turn depends on monetary policy.* In particular, in our stylized setup, the degree of pass-through that maximizes expected discounted profits of foreign firms selling in the domestic market satisfies:

$$Cov_{t-1}\left[\left(MC_t^* \cdot \mathcal{E}_t^{1-\eta_t}\right),\ (-\ln \mathcal{E}_t)\right] = 0$$

Trivially, if $\mathcal{E}$ is constant or fully anticipated, *any* degree of pass-through (including zero) is consistent with the previous expression. But if $\mathcal{E}$ is not perfectly predictable, the optimal degree of pass-through will be a function of its covariance with marginal costs.

To build intuition: suppose marginal costs MC^* are high in those states of nature in which the Home currency appreciates. By choosing a high degree of pass-through, the Foreign firms can insulate their export revenue from exchange rate movements. But this will make unit profits quite volatile: revenue will be constant in local currency, while its marginal costs will fluctuate with the exchange rate. By choosing a low pass-through, however, Foreign producers will make their revenue also fluctuate with the exchange rate, and covary positively with marginal costs. In other words, a low pass-through implies that export revenues increase in tandem with marginal costs, so to stabilize unit profits.

In general, when choosing the optimal degree of pass-through, a firm equates the 'marginal costs' of imperfect pass-through, in terms of reduced expected revenue, with the 'marginal benefits' of imperfect pass-through, in terms of an increasing covariance between revenue and marginal costs.

4.3 The possibility of self-validating exchange rate regimes

In general equilibrium, pricing and monetary policy will be jointly and optimally chosen. Borrowing from Corsetti and Pesenti (2002), I now characterize the equilibrium by combining *optimal pass-through and optimal monetary policy.* Let η^* index the degree of exchange rate pass-through into the Foreign country (relevant for Home exporters). Let μ^* denote the monetary stance in the Foreign country. In equilibrium (a) Home and Foreign firms choose the levels of pass-through η_t^* and η_t on the basis of their information at time $t-1$ regarding marginal costs and exchange rates at time t; (b) Home and Foreign monetary authorities set their rules taking the levels of pass-through η_t^* and η_t as given. Specifically, setting $\gamma = 1/2$ for simplicity, firms solve

$$\text{Home: } Cov_{t-1}\left(MC_t/\mathcal{E}_t^{1-\eta_t^*}, \ln \mathcal{E}_t\right) = 0$$

$$\text{Foreign: } Cov_{t-1}\left(MC_t^* \mathcal{E}_t^{1-\eta_t}, -\ln \mathcal{E}_t\right) = 0$$

Monetary authorities solve

$$\begin{aligned} & \text{Home:} \\ 1 &= \frac{1}{2}\frac{MC_t}{E_{t-1}\left(MC_t\right)} + \frac{1}{2}\frac{\left(1-\eta_t\right)MC_t^*\mathcal{E}_t^{1-\eta_t}}{E_{t-1}\left(MC_t^*\mathcal{E}_t^{1-\eta_t}\right)} + \frac{\eta_t}{2} \\ & \text{Foreign:} \\ 1 &= \frac{1}{2}\frac{MC_t^*}{E_{t-1}\left(MC_t^*\right)} + \frac{1}{2}\frac{MC_t/\mathcal{E}_t^{1-\eta_t^*}}{E_{t-1}\left(MC_t/\mathcal{E}_t^{1-\eta_t^*}\right)} + \frac{\eta_t^*}{2} \end{aligned}$$

The 'circularity' in the equilibrium is apparent. Optimal pass-through depends on monetary policy rules. Optimal monetary rules depend on pass-through. This is what raises the possibility of self-validating exchange rate and monetary regimes. Indeed, the stylized model underlying the above algebra has two equilibria.

A first equilibrium is an OPTIMAL FLOAT (OF), characterized as follows:

$$\begin{aligned} MC_t &= E_{t-1}\left(MC_t\right), \qquad MC_t^* = E_{t-1}\left(MC_t^*\right) \\ \eta_t &= \eta_t^* = 1 \end{aligned}$$

The main features of this equilibrium are: (a) exchange rate pass-through is complete, hence depreciation has expenditure switching effects; (b) monetary policies fully stabilize the national economies by closing output gaps; (c) exchange rates are volatile, their conditional variance being proportional to the volatility of fundamentals.[4]

Note that exchange rate movements implied by optimal monetary policy foster efficient relative price adjustment, as in the Friedman (1953) case. Different from OCA theory, however, the beneficial role of exchange rate movements is not independent of monetary stabilization. On the contrary, it strictly depends on it.

The other equilibrium is an optimal fixed exchange rate or *de facto* monetary union — an *Optimal Monetary Union (OMU),* whereas the attribute 'optimal' refers to the policies followed by all (private and public) agents in the economy*:*

$$\begin{aligned} 1 = \frac{1}{2}\frac{MC_t}{E_{t-1}\left(MC_t\right)} + \frac{1}{2}\frac{MC_t^*}{E_{t-1}\left(MC_t^*\right)}, \;\; => \qquad & \mathcal{E}_t \; const, \\ \eta_t &= \eta_t^* = 0 \end{aligned}$$

In this equilibrium, optimal national monetary policies are fully symmetric, and therefore cannot insulate the national economies from asymmetric shocks; they

[4] To understand the *logic underlying Optimal Float:* when domestic monetary authorities completely stabilize marginal costs, firms would never choose incomplete pass-through, as this would imply that exchange rates 'destabilize' their revenues, reducing expected discounted profits. By choosing 100 percent pass-through, firms' unit profits are insulated from exchange rate and foreign monetary policy shocks. Then domestic monetary authorities find it optimal to stabilize domestic marginal costs and output gap.

close output and employment gaps only on average. Pass-through is zero (but this hardly matters since the exchange rate is fixed).[5]

The result above is in many respects special. Yet, it is surprisingly robust to important modifications of the analysis. Specifically, consider the following two core questions. The first is: *Would policy cooperation eliminate self-validating OMU?* One may argue that policymakers in a monetary union would set their rules cooperatively, rather than independently. Would the equilibrium allocation be unique, once cooperative policies are allowed for? In the above economy, the answer is no.

Allowing for cooperation does not modify our conclusions at all. Optimal policy rules conditional on $\eta, \eta^* = 1$ are exactly the same in a Nash equilibrium and under coordination: there are no gains from cooperation in the OF scenario which replicates the flex-price allocation (a point also stressed by Obstfeld and Rogoff (2002)).

Also, optimal policy rules conditional on $\eta, \eta^* = 0$ are identical with and without cooperation: since exchange rate fluctuations are the only source of international spillover, there cannot be gains from cooperation when non-cooperative monetary rules already imply stable exchange rates!

The other question is: *would financial integration make a difference?* In general, the structure of asset markets has profound implications for the equilibrium allocation. It is a well-known proposition of OCA theory that a high level of consumption risk-sharing can reduce the cost of entering a monetary union.

Notably, however, the model underlying our analysis is such that the allocation does not depend on a particular structure of financial markets. The solution is identical whether or not consumers have access to financial assets, including noncontingent bonds and/or contingent bonds. This property of the model follows from the role of the terms of trade movements, which insure by themselves efficient risk sharing: the correlation of domestic consumption weighted by domestic prices is always perfect, as implied by perfect international consumption risk sharing.

4.4 Macroeconomic features of Optimal Monetary Unions

There are at least three lessons from the above analysis. I discuss them below.

Output correlation is higher in an optimal monetary union Output correlation in an optimal float (OF) depends on the degree of asymmetry of the

[5] To understand *the logic underlying OMU:* since the exchange rate is predictable, currency denomination of prices is not a concern. Firms may adopt 'local currency pricing'. But if Home and Foreign firms choose $\eta = \eta^* = 0$, Home and Foreign authorities are concerned with the price-distortions of exchange rate volatility. They optimally choose to stabilize an average of domestic and foreign marginal costs. With identical preferences, they end up stabilizing exactly the same weighted average of marginal costs. With identical monetary policy, the exchange rate is fixed.

fundamental shocks:

$$Corr\left(Y_t^{OF}, Y_t^{*OF}\right) = Corr\left(Z, Z^*\right)$$

In an OMU output levels are instead strongly correlated

$$Corr\left(Y^{OMU}, Y^{*OMU}\right) = 1 \geq Corr\left(Y^{OF}, Y^{*OF}\right)$$

for any given distribution of fundamentals. To appreciate this result, note that it is independent of any structural change towards endogenous OCA of the type stressed by Frankel and Rose (1998).

A well-known argument by Frankel and Rose (1998) is that countries joining a monetary union can acquire the attributes of optimum currency areas *ex post*, if a boost of intra-industry trade makes their economic structure more symmetric. Clearly, a boost in intra-industry trade may reduce the incidence of country-specific shocks that, with nominal rigidities, could motivate country-specific stabilization policies.[6] In general, structural reforms or institutional changes brought about by economic integration may change the degree and type of heterogeneity over time. These kind of considerations are sometimes taken as the theoretical motivation for monitoring convergence in national growth rates as an indicator of increasing symmetry within the union (weakening the case for independent monetary policy). The results from the optimizing model above sheds light on possible fallacies of this reasoning.

The point is national GDP growth rates may be highly correlated in a monetary union, even when this is not the optimal regime, as a result of endogenous changes in pricing and production decisions by firms, and optimal monetary policy stance by the single monetary authority.

Business cycle synchronization In an OMU, output is strongly correlated, but the output gap is not. To wit: with optimal monetary rules in place, a positive productivity shock in one country will tend to open a positive output gap domestically, but a negative output gap elsewhere in the MU (recall that in an OF both domestic and foreign output would be at their potential).

These considerations suggest that synchronization in growth rates may be a misleading indicator of symmetry in fundamentals. Clearly, the correct indicator of business cycle convergence is the output gap, rather than growth rates. Yet, there are measurement issues, which make a proper assessment of potential output and output gap quite difficult in practice.

To see this, in the above model, potential output is identified with the flex-price level of activity. In the current practice of international organizations and domestic institutions, however, potential output is approximated by fitting trends on the available time series of output. In light of our results we can say something about the measurement bias in these standard approximations.

[6] One may nonetheless note that the same process may magnify asymmetries across sectors within each area — also limiting the ability of monetary authorities to stabilize the union-wide economy (although the political economy of sectoral differences is quite different from that of national differences within a monetary union).

The literature has pointed out that potential output may not be at all a smooth variable, hence estimates of output gaps may be quite off-the-mark. In addition, we have seen that in an OMU national output moves synchronically at a lower average level than in a flex-price equilibrium. Hence, fitting a trend through the time series of actual output implies that average 'potential output' is underestimated, relative to the theoretically consistent definition of it.

National welfare Although the private and the public sector 'do the right thing' once the equilibrium with a monetary union is selected (*self-validating OMU*), a move toward more volatile rates and less synchronized business cycles would bring about the appropriate change in firms' pricing and pass-through strategies. In turn, these changes would validate the floating regime as optimal (*self-validating Optimal Float*).

In welfare terms, the optimal monetary union is Pareto-inferior to the Friedman-style arrangement. These considerations provide yet another argument suggesting caution in using import price stability in local currency as an argument in favor of monetary union — in addition to the points discussed in Section 6 below.

5 More costs of insufficient stabilization and monetary unions

5.1 Inflation dispersion

It is well understood that in models with partial price adjustment, incomplete stabilization of output gaps generates inflation variability and inflation dispersion. Differences in inflation rates across countries (or sectors) may reflect desirable adjustment in international relative prices — and therefore be welfare-enhancing. However, in models with staggered price adjustment, inflation dispersion has also negative implications for efficiency, as inflation distorts relative prices (to wit: with staggered adjustment, the market price of ex-ante symmetric goods in preferences and production is not necessarily symmetric). Hence, the design of optimal monetary policy in a currency union must address the trade-off between the benefit of inflation in fostering relative price adjustment *across types of goods*, and its costs in terms of relative price distortions *within categories of goods*.

Elaborating on this trade-off, recent contributions have argued that central banks should target inflation in those sectors/countries that have the highest degree of inflation persistence. The reason is straightforward. Suppose some fundamental shock creates the need for adjustment in relative prices across different type of goods, or across countries. In response to these shocks, it is highly inefficient to place the burden of price adjustment on sectors/countries that have high and persistent nominal rigidities. If policy makers try to do so, adjustment will take time, and it will be costly due to distortions in relative prices of similar goods – since some firms will happen to adjust prices early on,

others will happen to adjust prices at a later time. Conversely, it is efficient to pursue policies that target desired relative price adjustment via nominal price changes in the most flexible sectors or countries of the union. Clearly, adjustment will be faster and less costly.

An important relative price affecting the dispersion of national inflation rates in a monetary union is that between traded and nontraded goods. As is well known, these sectors could potentially have different inflation rates reflecting fundamentals such as productivity growth differentials between manufacturing and services. But they could also respond differently to demand shocks. A crucial empirical issue is to what extent inflation differentials in a monetary union are driven by nontraded price variability.

5.2 Investment and firms' entry

There are a number of possible directions of theoretical research developing along the lines sketched in Section 3 above. For instance, recent literature has developed models with entry and exit of firms (see Ghironi and Melitz (2004), Corsetti, Martin and Pesenti (2004), among others), with very promising results. Preliminary work with models including both firms' entry and nominal price rigidities confirms the main result of Section 3: lack of stabilization exacerbates monopolistic distortions and raise the price level. In addition, it suggests that insufficient stabilization at national level reduces the number of firms created in equilibrium, hence depresses the level of investment relative to the flex-price allocation benchmark.

Some of these models also introduce yet another dimension to the costs of business cycle. Since firms produce differentiated goods, the welfare implications of fluctuations in economic activity that expand or contract the array of goods available to consumers are magnified by the degree of households' 'love of variety.'

5.3 Market segmentation and pricing to market

Recent models have focused on the macroeconomic aspects of optimal pricing-to-market in models allowing for distribution services intensive in local input. Because of these services, the consumer price of goods has a sizeable component in local costs. Previous joint work with Luca Dedola suggests that, to the extent that incomplete stabilization at national level raises the price for nontradables including distribution services, distribution margins will tend to be higher in an optimal MU relative to an OF. Larger distribution margins may create further opportunities of market segmentation and price discrimination, running counter other desirable effects of a single currency on price dispersion.

5.4 Fiscal policy and the provision of public goods

As is well known, stabilization properties of fiscal policy will in general depend from the fiscal instrument that the government uses (taxation, government

spending on consumption or investment), the distortionary nature of taxation, and financial and nominal frictions affecting the transmission of demand and tax shocks. The analysis of fiscal policy thus raises the issue of choosing among different possible specifications of instruments and economic structure. The macro literature has moved some steps towards a more realistic treatment of this issue, accounting for distortionary taxes and spending on useful public goods, and/or introducing liquidity constrained agents in general equilibrium models. In this text, I will limit my analysis to a simple example that is somewhat useful to explore the attributes of an optimal policy mix (see Galì and Monacelli (2004)).

Assume that taxes are lump sum and government spending falls on useful public goods which provide utility to the representative national consumers. We observe at first that, in a Pareto-efficient allocation, government spending should be higher in states of nature where productivity is high, since it is efficient to produce more (private and public) goods in these states of nature. To characterize an equilibrium allocation with an optimal policy mix, recall the main result of the previous section: with nominal rigidities, monetary policy should be expansionary when productivity is high. In an optimal float, then, we may expect that optimal monetary policy and fiscal policy should both be expansionary in response to a positive productivity shock. Indeed, in an Optimal Float, private and public consumption will be highly correlated: they both increase with positive productivity shocks.

In an optimal monetary union, however, it is reasonable to expect that the correlation between these two policies be lower. Specifically, consider the optimal single monetary response to a positive productivity shock in the Home country. As average productivity is higher in the union, monetary policy will be expansionary, raising both domestic and foreign private consumption. But since by assumption productivity has not changed in the Foreign country, the single monetary policy will move output gaps in different directions: output will be too low in the Home country (since the shock is not fully stabilized); it will be too high in the Foreign country. What about fiscal policy? Clearly, it will be optimal to expand government spending on public goods in the Home country, where productivity is high. It will not be optimal to raise public spending in the Foreign country, where productivity has not changed. Actually, welfare could be improved by reducing, at the margin, public activity, to compensate (at least partially) for the high employment rates driven by monetary policy.

In an optimal monetary union, therefore, the optimal policy mix differs at national level, requiring fiscal policy to be anticyclical depending on domestic conditions. Government spending should always move to close output gaps. In some countries this will require both fiscal and monetary policy to be expansionary. In others, fiscal policy should be used to cool down the national economy response to a monetary shock motivated by cyclical conditions elsewhere in the union. This is clearly not optimal, relative to the benchmark case of complete stabilization and efficient provision of public goods.

Note that this simple model abstracts from liquidity-constrained households ('rule of thumb' consumers). In their presence, spending and taxation policy can also have a direct effect on private consumption through disposable income,

breaking Ricardian equivalence.

6 Is the absence of expenditure switching effects of exchange rate movements a reason to prefer fixed exchange rate arrangements?

We can now turn to the second 'pillar' of the traditional OCA theory – i.e., the canonical view of exchange rate movements as efficient substitutes for relative price adjustment (a view exemplified by Friedman (1953)). Recent literature has strongly questioned such a view.

Several authors, including Betts, Devereux and Engel, have stressed empirical evidence on a low short-run elasticity of consumer prices with respect to the exchange rate. To the extent that this is due to nominal rigidities in the goods markets, exchange rate movements do not have the important expenditure switching effects postulated by traditional theory. Actually, exchange rate movements have destabilizing spillovers on firms' profits (with export price preset in foreign currency, depreciation does not redirect world demand towards domestic products, but lowers firms' revenues from their export markets).

Indeed, postulating that prices are preset in local currency, a series of contributions in the so-called 'new open-macro macroeconomics' (NOEM) have derived optimal monetary policy rules which actually imply complete exchange rate stability. But if exchange rates do not contribute to relative price adjustment in the short run, an important argument against monetary union disappears. In other words, these theoretical contributions raise an important policy question: *Is 'local currency price stability' of imports an argument in favor of monetary union?* In light of the empirical evidence, this question is quite relevant: most empirical studies weigh in favor of local currency price stability of imports (reflected in large deviations from the law of one price associated with exchange rate movements), which may be due to nominal rigidities.

The answer to the above question is, however, 'no' (or 'not necessarily'). Specifically, the absence of expenditure switching effects from exchange rate movements is not necessarily an argument in favor of a fixed exchange rate regime, for obvious reason.

A number of authors have recently formalized this point: Duarte and Obstfeld (2004) assume traded and non traded goods in a model with 'local currency pricing.' In the presence of asymmetric shocks to the nontraded good sector, the central bank may find it optimal to react to a shock to this sector, even if the implied exchange rate movements do not produce desirable expenditure switching effects. For instance, the central bank may find it optimal to expand aggregate demand in response to a positive productivity shock to nontradables, although the nominal depreciation implied by such policy hurts domestic exporters.

By the same token, after arguing in favor of fixed exchange rates, Devereux and Engel (2004) also stress the possibility of 'competing objectives' for monetary policy – i.e. policy trade-off that may undermine optimality of fixed rates.

These authors contrast aggregate demand effects of monetary policy with relative price effects under different assumptions about nominal rigidities and the elasticity of substitution in the goods market, distinguishing between intermediate goods and final goods.

7 Summing up

Monetary theory has recently stressed efficiency costs of inflation dispersion in the presence of nominal rigidities. In a single currency area, some inflation dispersion will be the unavoidable costs of relative price adjustment across sectors and regions.

In this text, I have argued that the same class of models highlighting the costs of inflation dispersion also point to a different cost of incomplete stabilization at national level. This cost consists of a wedge between expected output and its efficient level. Growth rates are not affected, but in expected terms the level of activity is too low, as incomplete stabilization at national level exacerbates monopolistic distortions. Future research may provide a more accurate assessment of the magnitude of this wedge, both numerically and empirically. However, simple back of the envelope calculations suggest that the associated welfare loss is small.

Moreover, I have argued that convergence in growth rates is not necessarily an indicator that heterogeneity in business cycle is falling. Whether Europe is becoming an optimal currency area is hard to say. The model of monetary union as a self-validating regime suggests that there could be persistent economic costs due to heterogeneity even if growth rates converge after monetary unification.

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