Regional Currencies

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Abstract: Projects of regional monetary integration have flourished around the world, especially among developing countries. Remarkably, none of the proposed regional unions come close to the traditional definition of an "optimum currency area" (OCA), casting doubt on the soundness of analyses relying solely on OCA criteria. We propose a broader, yet compact, theoretical model explaining the formation of multilateral currency areas. Drawing on the European integration literature, it combines the traditional OCA arguments with other potential effects of regional integration such as the induced coordination of monetary policies and the greater political independence of supranational central banks with respect to national ones. It also emphasizes the importance of fiscal convergence to ensure the stability of the union.

JEL classification codes: E58, E61, E62, F33.

♦ Without implication, I wish to thank Paul Masson and Catherine Pattillo for many useful comments and discussions. This paper extends the formal model used in joint work (Debrun, Masson and Pattillo, 2002, 2003). The views expressed here are my own and do not necessarily reflect those of the International Monetary Fund. All errors are mine.

I. INTRODUCTION

Projects of regional monetary unions have been flourishing around the world. While many of those remain vague, others are already well underway, including a detailed integration strategy, a timetable for the establishment of the new currency, and an institutional infrastructure at the regional level. Perhaps surprisingly, the proposed currency areas[1] often concern groups of developing economies that hardly come close to the traditional definition of an "optimum currency area" (OCA), such as West Africa (Bayoumi and Ostry, 1997, and Masson and Patillo, 2001), Latin America (Berg, Borensztein and Mauro, 2003), the Gulf States (Fasano et al. 2003) or Southeast Asia (Mundell, 2003). According to OCA theory, economies that tend to trade relatively little among themselves and to specialize in a limited number of commodities are vulnerable to large country-specific external shocks and therefore less likely to be better off by abandoning key benefits of a national currency such as independent monetary policy and unconstrained exchange rate adjustments. While the standard OCA literature identifies the determinants of the costs associated with the loss of monetary autonomy, it fails to clearly account for its benefits.[2] Among the latter, we find less politicized institutions governing monetary and fiscal decision-making and the induced efficiency gains resulting from the wider use of a single currency – mainly in terms of lower transaction costs and absence of exchange rate uncertainty. The vast literature on European monetary integration offers detailed insights on the role of macroeconomic institutions in reshaping the monetary-fiscal policy mix (e.g., Martin, 1995, Beetsma and Bovenberg, 1998, Debrun, 2000, or Dixit and Lambertini, 2003) while more recent theories encompass traditional OCA arguments, institutional effects and the potential impact of monetary integration on intra-regional trade flows (Alesina and Barro, 2002).

This paper draws on the existing literature to propose a tractable model of the formation of stable regional currency unions. The model is kept as simple and as transparent as possible to allow for calibration exercises that include developing regions with only minimal data requirements (see Debrun, Masson and Patillo, 2002). It captures both OCA arguments and the role of the institutional environment facing decision makers. We believe that, at least over the time horizon that matters to policymakers, these aspects overwhelmingly dominate the intra-regional trade-creation effects attributed to monetary unification, and about which considerable uncertainty remains (see for instance Frankel and Rose, 2002, Rose, 2002, and Alesina, Barro and Teynrero, 2002).

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[1] In this paper, we use the terms currency union, monetary union and currency area interchangeably to designate a geographic entity within which monetary policy is credibly placed under the responsibility of a single authority.

[2] See Mongelli (2002) for a recent and comprehensive survey of the OCA literature.

The model incorporates problems that are particularly relevant in developing economies, such as tight borrowing constraints and a tendency by governments to live beyond their means – for instance because of costly and inefficient tax collection process that yield too little to cover basic expenses or because of policymakers' private incentives to overspend. In that context, seigniorage often remains a significant – or at the very least an attractive – source of government revenue. Since *de jure* central bank independence does not necessarily result in *de facto* independence (Gutiérrez, 2003), monetary authorities partly give in to governments' pressures to levy seigniorage revenues, and to boost economic activity above potential output so as to temporarily lessen the symptoms of structural inefficiencies. This leads to a well-known inflationary bias (Barro and Gordon, 1983).

The model departs from the premises adopted by Dornbusch (2001), Alesina and Barro (2002) and Alesina, Barro and Teynrero (2002) who view monetary integration (or more precisely the reduction in the number of national currencies in the world) as a process of "dollarization" involving "client-anchor" relationships between fortunate countries with "good monies"[3] (like the dollar, the euro and the yen) and the unfortunate rest of the world. If dollarization is admittedly one way to get rid of "bad monies", the formation of multilateral monetary unions leading to the creation of new regional currencies replacing national ones is an emerging trend that this paper specifically addresses and that, as we show, is not incompatible with the preference of some countries for dollarization (see Alexander and von Furstenberg, 2000, for an informal discussion about dollarization vs. monetary unification). Our analysis provides two key original insights. First, we put the emphasis on country-specific fiscal distortions likely to be highly relevant in developing economies, underscoring the instrumental role of fiscal convergence and reforms in the monetary integration process. Second, we provide a framework that explicitly deals with the institutional dimension of regional integration efforts. In particular, we study the endogenous formation of currency unions.

The model characterizes the world monetary geography, emphasizing the following elements:

1. Countries facing greater difficulties to commit to price stability have stronger incentives to join a monetary union because of the induced separation of monetary and fiscal powers. Such separation implies that monetary unification is a substitute for central bank independence. Hence, countries that manage to credibly delegate the conduct of monetary policy to an independent, national central bank may be less likely to benefit from participating in a currency union.

2. Fiscal distortions are critical determinants of the net welfare gain to join a given monetary union. In particular, disparities in fiscal distortions negatively affect the gains of many potential member states so that mechanisms of fiscal convergence (or coordinated

[3] See Dornbusch (2001)

fiscal reforms) contribute to increase the size of stable monetary unions and reduce the number of currencies in the world.[4]

3. Greater trade integration and greater similarity in real shocks increase the net welfare gains from monetary unification because of the larger benefits expected from the automatic coordination of monetary policies (absence of competitive devaluation). Again, this contributes to a reduction in the number of national currencies and the formation of larger currency blocks.

4. The different size of countries is also an important determinant of monetary geography. First, big countries generally account for a large share of smaller countries' trade flows, making them attractive partners of a monetary union. Second, decisions adopted by supranatational institutions tend to give more importance to large countries's objectives, either by mandate or because of the big players' bargaining power. Large countries are therefore more likely to be anchors of hegemonic currency unions.

5. Overall, the analysis suggests that stable currency unions can be envisaged for very different groupings of countries and take very different forms. Specifically, one might envisage monetary unions between low income, weakly integrated countries (because of the large benefits in terms of credibility) without putting into question the more traditional unions envisioned by Mundell (1961), Kenen (1963) and McKinnon (1969) for whom high-income, well integrated countries would be chief candidates to currency unions because of the efficiency gains that result and the relatively low cost of loosing monetary autonomy. Our analysis also recognizes the fact that monetary unions can be very different in nature. Depending on the relative size and relative institutional capacities of the countries, stable currency unions can be multilateral (joint decision process from which new and better currencies emerge) or unilateral (the hegemonic type through which bad currencies are eliminated and replaced by a few good national currencies with an international role). Finally, the analysis indicates that many different monetary maps are possible for the same world economy, suggesting that coalitions may change over time. The dynamics of currency geography is certainly emerging as an important topic on the research agenda (one first attempt in that direction is Yehoue, 2003), especially in regard of the recent arguments suggesting that OCA criteria might be endogenous (see Frankel and Rose, 2002, and Corsetti and Pesenti, 2002).

The rest of the paper proceeds as follows. Section II presents the basic model. Solutions under autonomy, including the inefficiencies of discretionary monetary and fiscal policies, are discussed in Section III. The incentives to form a monetary union are reviewed in Section IV while Section V investigates the possible configurations of stable monetary unions. Concluding remarks and policy implications constitute Section VI.

[4] Hefeker (2003) investigates the reverse linkage, showing that monetary unification may increase the incentives of member states to implement fiscal reforms.

II. THE MODEL

This section presents the stylized theoretical framework supporting our analysis. The model draws on the extensive literature on European monetary integration, in particular Beetsma and Bovenberg (1998, 1999) and Martin (1995). These studies emphasize two major dimensions of monetary unification: the coordination of national monetary policies[5] and the anti-inflationary credibility of *supranational* monetary authorities. Our approach is close to Alesina, Angeloni and Etro (2003) who propose a general model explaining the emergence of international unions in which specific policy prerogatives are delegated to supranational authorities deciding by majority voting.

The world economy is represented by a static, *n*-good, *n*-country model. Countries differ by the size of their GDP, the tendency of their governments to live beyond their means – either because of an inability to raise enough fiscal revenues to cover socially desirable outlays or, alternatively, because of a propensity to spend on socially wasteful projects – and the shocks affecting output. As in most of the relevant literature, countries are described by log-linear equations where each variable represents a relative deviation from an arbitrary steady state.

In terms of notation, we designate by *N* the set of all countries while M_h is the set of countries belonging to a monetary union *h*. Variables or parameters indexed by either i, j or k are country-specific, while indices h and s designate variables or parameters common to all the member states of monetary unions h and s, respectively. The other variables or parameters are identical across all countries. The number of countries belonging to a monetary union h is denoted by m_h, with $m_h \in [2;n]$. The size of a country i is measured by its contribution to world output and symbolized by ω_i so that $0 < \omega_i < 1, \forall i \in N$ and $\sum_{i=1}^{n} \omega_i = 1$. All parameters are non-negative.

The economic environment facing policymakers is kept as simple as possible. First, output and inflation are linked by an expectations-augmented Phillips curve extended to allow for negative monetary policy externalities, as in Martin (1995). The externality is captured by parameters $\theta_{i,k}$ that represent the marginal effect of (unexpected) monetary expansion in country *k* on output in country *i*. These parameters are related to the size of the countries, the relative importance of bilateral trade linkages and the extent to which they

[5] A monetary union is a perfect substitute for fully cooperative monetary policy-making only in the case of symmetric shocks across member states (Canzoneri and Gray, 1985, von Hagen, 1993).

compete in third markets. Since governments partly finance spending through distortionary taxation, domestic tax policy τ_i – defined as an *ad valorem* tax on firms' total revenue (Alesina and Tabellini, 1987) – shifts the domestic Phillips curve. To keep the game-theoretic analysis tractable and focused on the monetary policy game, we assume that foreign tax policy does not affect domestic output, which is in line with the widespread argument in the literature that fiscal policy spillovers are either small or negligible (Beetsma and Debrun, 2003). Finally, the Phillips curve is affected by well-behaved (zero-mean, non-autocorrelated and finite variance $\sigma^2_{\varepsilon_i}$) country-specific shocks. If all countries retain monetary autonomy, each government faces the Phillips-curve equation.

$$y_i = \bar{y}_i + c\left(\pi_i - \pi_i^e - \tau_i\right) - \sum_{k=1}^{n} \theta_{i,k} c\left(\pi_k - \pi_k^e\right) + \varepsilon_i \ , \ i = 1,...,n \tag{1}$$

where $\bar{y}_i$ symbolizes the natural level of output in the absence of tax distortion, π_i is the inflation rate (controlled by the central bank), $\theta_{i,i} = 0$ and a superscript "*e*" denotes the rationally expected value of a variable.

If country i is part of a monetary union h, then the Phillips curve can be written as:

$$y_i = \bar{y}_i + c\left(1 - \theta_i^h\right)\left(\pi_h - \pi_h^e\right) - c\,\tau_i - X_h + \varepsilon_i, \ i \in M_h \tag{2}$$

where $\theta_i^h = \sum_{k \in M_h} \theta_{i,k}$, $X_h = \sum_{k \in N \setminus M_h} \theta_{i,k} c\left(\pi_k - \pi_k^e\right)$, and $\pi_k = \pi_h$, $\forall k \in M_h$, with π_h denoting the common inflation rate prevailing in all countries[6] participating in monetary union h. In the remainder of the paper, we assume that the non-distorted natural level of output is constant at its steady state value, so that, in our notation, $\bar{y}_i = 0$, for $i = 1,...,n$.

The second constraint faced by policymakers is government's solvency. In the present model, governments are unable to borrow so that public spending must equal total revenues (from taxation and seigniorage). This preserves the tractability of the game-theoretic analysis by keeping the model static (see Alesina and Tabellini, 1987, and, more recently, Dixit and Lambertini, 2003 for similar assumptions). The instantaneous budget constraint can be approximated by equation (3) below.

$$g_i = \mu\pi_i + \tau_i - \delta_i, \ i = 1,...,n \tag{3}$$

[6] That simplification ignores the Balassa-Samuelson effect and cross-country differences in the monetary transmission channels.

where g_i is the ratio of government spending to output and μ, the ratio of the inflation tax base to output. Parameter δ_i accounts for structural inefficiencies affecting fiscal policy, such as high tax collection costs, the appropriation of tax revenues by corrupt officials, and the allocation of scarce public resources to socially wasteful projects.[7] We model this as a fixed budgetary cost (as a ratio to output), meaning that the *relative* importance of those potential inefficiencies (as measured by δ_i/τ_i or δ_i/g_i) tends to decline with the capacity of governments to generate higher tax revenues and sustain greater expenditure in proportion of output.[8]

The representative government's utility function is quasi-linear as in Alesina, Angeloni and Etro (2003), Debrun (2001) and Muscatelli (1998). Generalizing the function used by Barro and Gordon (1983) to study credibility problems in monetary policy (linear in output and quadratic in the other arguments), we write:

$$U_i^G = \frac{1}{2}\left\{ -a\left(\pi_i - \tilde{\pi}\left(\varepsilon_i\right)\right)^2 - b\tau_i^2 - \gamma\left(g_i - \tilde{g}_i\right)^2 \right\} + y_i, \quad i = 1,...,n \tag{4}$$

The linear term indicates that the government always welcomes an increase in output, even in excess of the natural level. The other arguments are quadratic, indicating that deviations from socially optimal levels (denoted by a tilde) are increasingly costly. Since the linearity in output would a priori preclude stabilization policies, we restore a pseudo trade-off between the variability of inflation and the variability of output by making the socially desirable inflation rate contingent on output disturbances, as suggested by Muscatelli (1998). For convenience, we assume that $\tilde{\pi}\left(\varepsilon_i\right) = -\eta\varepsilon_i$, so that $\tilde{\pi}\left(0\right) = 0$ and $\tilde{\pi}'_{\varepsilon_i} < 0$. Hence, a negative (positive) output shock incites the government to tolerate positive (negative) inflation, implicitly to counteract output fluctuations.

Monetary policy is decided by a central banker whose utility function may differ from equation (4) due to specific institutional arrangements governing the relationship between monetary and fiscal authorities. In particular, we allow for the possibility that monetary

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[7] Hefeker (2003) adopts a similar specification of fiscal inefficiency. Inefficiencies in developing countries' fiscal policy design are well documented (Gupta et al. ,1997, 2000, Mauro, 1998, Robinson and Torvik, 2002).

[8] An obvious alternative would be to model fiscal inefficiencies as "iceberg costs", which amounts to assume a constant *marginal* distortion. However, the fixed cost conjecture has overwhelming advantages in terms of tractability. The solution of the model with iceberg costs (available upon request) yields similar results so that we do not expect the subsequent analysis of monetary integration under the iceberg costs assumption to be qualitatively different.

policy be set by a politically independent central banker whose mandate is to deliver the socially optimal inflation rate – see Berger, de Haan and Eijfinger (2000) for a recent assessment. Indeed, as shown by Barro and Gordon (1983) and Rogoff (1985), a dependent central bank sets inflation too high because of the systematic incentive to expand output beyond potential. In the present model, instructing a fully independent central bank to ignore the level of output when choosing monetary policy proves sufficient to suppress that incentive (see Schellekens, 2002 and Section III).[9] Such central bank would maximize a utility function U_i^C defined as: $U_i^C \equiv U_i^G - y_i$. In practice however, even legally independent central banks remain under the pressure of governments, especially when institutional weaknesses make the separation of powers imperfect. To account for political influence (or partial independence), we follow Eijfinger and Hoeberichts (1996) and define the central bank's utility function as a convex combination of U_i^G and U_i^C.

$$U_i^{CB} \equiv \lambda_i U_i^G + (1-\lambda_i)\, U_i^C = U_i^C + \lambda_i y_i, \text{ with } \lambda_i \in [0;1] \text{ and } i = 1,...,n \tag{5}$$

where λ_i represents the extent of government's i influence on the conduct of monetary policy. Importantly, equation (5) presupposes that (partially) independent central banks (i.e. $\lambda_i < 1$) internalize the role of the inflation tax in financing socially desirable public expenditure.

III. AUTONOMOUS MONETARY AND FISCAL POLICIES

The analysis of optimal policies is carried out under standard assumptions. We assume complete information, rational expectations, flexible prices, nominal wage contracts and the following sequence of events: (i) binding nominal wage contracts are signed – reflecting expected inflation, (ii) shocks are realized and perfectly observable and (iii) the authorities simultaneously choose monetary and fiscal policies. With autonomous monetary policies, each national central bank sets the rate of inflation so as to maximize (5) whereas governments choose effective tax rates with the aim to maximize (4), in both cases under the constraint of (1) and (3), and taking expectations as given. The resulting pure-strategy Nash equilibrium characterizes the set of time-consistent macroeconomic policies under a fully flexible exchange rate regime. Solving the system formed by equation (3) and the first-order conditions for a maximum of (4) and (5), we find:

$$\pi_i^* = \frac{\gamma\mu b}{\Lambda}(\tilde{g}_i + \delta_i) + \frac{\lambda_i(b+\gamma)+\gamma\mu}{\Lambda} c - \frac{a(b+\gamma)\eta}{\Lambda}\varepsilon_i, \; i = 1,...,n \tag{6}$$

[9] A formal demonstration of that well-known result in the context of our model is straightforward and available upon request.

$$\tau_i^* = \frac{\gamma a}{\Lambda}\left(\widetilde{g}_i + \delta_i\right) - \frac{\gamma\mu\ \left(\lambda_i + \mu\right) + a}{\Lambda} c + \frac{a\gamma\mu\eta}{\Lambda}\varepsilon_i,\ i = 1,...,n \tag{7}$$

$$g_i^* = \frac{\gamma\left(a + \mu^2 b\right)}{\Lambda}\widetilde{g}_i - \frac{ab}{\Lambda}\delta_i + \frac{\lambda_i b\mu - a}{\Lambda} c - \frac{ab\mu\eta}{\Lambda}\varepsilon_i,\ i = 1,...,n \tag{8}$$

with $\Lambda = a\left(b + \gamma\right) + \gamma\mu^2 b > 0$

As established by Barro and Gordon (1983) under similar assumptions, the time-consistent policy mix described by equations (6) to (8) is characterized by excessive inflation as long as the government can successfully pressure the central bank to stimulate demand beyond the natural level of output, which is the case for any non-zero value of λ_i. By contrast, a completely independent central bank mandated to achieve the socially optimal inflation rate ($\lambda_i = 0$) resists such pressures, preventing the inflationary bias.[10]

Setting aside the distortions caused by political manipulations of monetary policy (that is setting $\lambda_i = 0$), we can identify the policy trade-offs reflected in the socially optimal policy mix of each country. First, average public expenditure falls short of the social target because both sources of government revenue (taxation and inflation) entail costs, either directly (*b*) or through their impact on output (*c*), and because resources are wasted in tax collection or socially useless projects (δ_i). Second, distortionary taxes fail to fully finance public spending so that to close the financing gap, average inflation is positive. In equation (6), the term in $\widetilde{g}_i$ captures the trade-off between the need to finance socially beneficial expenditure and the direct welfare cost of inflation while the term in *c* (with $\lambda_i = 0$) represents an additional incentive for monetary financing due to the output loss stemming from taxation. Finally, all policy instruments are contingent on the supply shock although the state-contingency of fiscal variables only reflects an adjustment to monetary stabilization measures. It should be kept in mind that the solution under full central bank independence is only a second best solution, and this for two reasons. First, output remains suboptimally low, because of structural distortions (unrelated to taxes but reflected in the linear output term in (4)), and the unavailability of a non-distortionary tax instrument.[11] Second, inefficiencies in the public sector (δ_i) leads to higher inflation, higher tax rates (which further depress output) and lower public expenditure.

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[10] Given the quasi-linear utility functions adopted here, the concept of central bank independence is equivalent to the notion of "conservatism" in the conduct of monetary policy (in the sense popularized by Rogoff, 1985, that is a greater aversion to inflation than Society).

[11] See Beetsma and Debrun (2003) for a simple generic model of the policy mix with both lump-sum and distortionary taxation.

Under complete information, economic agents recognize eventual incentives of the central bank to stimulate production above potential ($\lambda_i > 0$), and adjust inflation expectations accordingly. Hence, in equilibrium, government intervention in the conduct of monetary policy merely results in a *suboptimal* shift of the burden of financing expenditure from taxation to inflation, with repercussions on output and spending (see Alesina and Tabellini, 1987, and, for a survey of related models, Beetsma and Debrun, 2003). Whereas higher output reflects smaller tax rates, public spending increases.

$$\pi_i^*(\lambda_i) - \pi_i^*(0) = \frac{\lambda_i(\gamma + b)}{\Lambda} c > 0 \tag{9}$$

$$\tau_i^*(\lambda_i) - \tau_i^*(0) = -\frac{\lambda_i \mu \gamma}{\Lambda} c < 0 \tag{10}$$

$$g_i^*(\lambda_i) - g_i^*(0) = \frac{\lambda_i \mu b}{\Lambda} c > 0 \tag{11}$$

$$y_i^*(\lambda_i) - y_i^*(0) = \frac{\lambda_i \mu \gamma}{\Lambda} c^2 > 0 \tag{12}$$

In the next section, we consider individual countries' incentives to form a given monetary union (MU) and compare the policy mix under MU to the flexible-rate benchmark derived above.

IV. The Policy Mix under Monetary Union

Participation in a MU implies a major institutional change: the credible delegation of monetary policy to a supranational central bank, the CCB. The impact on the policy mix in participating countries depends on the institutional features of the CCB, and in particular, on the way individual member states' situations affect its decisions, and on its effective insulation from political interventions. To discuss the "pure" effects of monetary unification, we characterize the incentives of a country i to participate in a monetary union h with $m_h - 1$ other countries, assuming that monetary authorities (national as well as supranational) are completely dependent on governments, that is $\lambda_1 = \lambda_2 = ... = \lambda_n = 1$. The role of institutions design and central bank independence will be discussed in Section V.

As monetary policy-making is now fully cooperative within the CCB, the latter picks a common inflation rate maximizing a convex combination of the participating *governments*' utility functions. Specifically, we assume that the CCB maximizes a size-weighted average of individual utility functions, which reflects the plausible conjecture that large countries would have a greater influence on the central bank.

$$U_h^{CCB} = \sum_{i \in M_h} \omega_i^h U_i^G \tag{13}$$

with $\omega_i^h = \omega_i \Big/ \sum_{i \in M_h} \omega_i$

The reaction function of the CCB is found by maximizing (13) under the constraint of (2) and (3), and assuming given expectations.

$$\pi_h^* = \frac{\gamma\mu}{a+\gamma\mu^2} \sum_{i \in M_h} \omega_i^h \left(\tilde{g}_i + \delta_i - \tau_i\right) + \frac{1 - \sum_{i \in M_h} \omega_i^h \theta_i^h}{a+\gamma\mu^2} c - \frac{a\eta}{a+\gamma\mu^2} \sum_{i \in M_h} \omega_i^h \varepsilon_i \tag{14}$$

Equation (14) indicates that the common monetary policy now depends on the cross-country average expenditure target and fiscal distortion. Similarly, monetary policy reacts only to cross-country average tax policy. This limits the inflation effect of an individual member state's fiscal stance to a fraction ω_i^h of what it was under monetary autonomy.[12] Joint policymaking also implies that monetary policy only stabilizes the cross-country average supply shock. Finally, the CCB internalizes the negative output externality of national monetary policies. The incentive to boost output through monetary expansion is consequently lessened, leading to a reduction in the inflationary bias. In that sense, monetary unification emerges as a substitute for greater central bank independence (that is a smaller λ_i) even though we assume the CCB remains under the influence of individual governments. This is a particularly important effect for countries with weak capacities to build credible macroeconomic institutions of their own.

The first order conditions for optimal taxation being unaffected by monetary unification, it is straightforward to characterize the time-consistent policy mix for all member states of *h*. To avoid cumbersome expressions, we introduce the following notation:

- $x_A^h = \sum_{i \in M_h} \omega_i^h x_i$, for $x \in \left\{ \tilde{g}, \delta, \theta, \varepsilon \right\}$ (cross-country averages within *h*),
- $\Psi_i^h = \tilde{g}_A^h / \tilde{g}_i$ and $\Phi_i^h = \delta_A^h / \delta_i$ to locate country i in the cross-country distribution of spending objectives and fiscal distortions respectively (a value below 1 indicating above average values). Alternatively, we can also write the solution in a way that emphasize the role of deviations of fiscal variable from the union's average. Accordingly, we define $\Gamma_i^h = \left(\tilde{g}_i + \delta_i\right) - \left(\tilde{g}_A^h + \delta_A^h\right)$.

[12] See also Beetsma and Bovenberg (1998).

This allows to write:

$$\pi^*_{i,h} = \pi^*_h = \frac{\gamma\mu b}{\Lambda}\left(\Psi^h_i \widetilde{g}_i + \Phi^h_i \delta_i\right) + \frac{\left(1-\theta^h_A\right)\left(b+\gamma\right)+\gamma\mu}{\Lambda} c - \frac{a\left(b+\gamma\right)\eta}{\Lambda}\varepsilon^h_A \quad , \ \forall i \in M_h \tag{15}$$
$$= \frac{\gamma\mu b}{\Lambda}\left(\widetilde{g}^h_A + \delta^h_A\right) + \frac{\left(1-\theta^h_A\right)\left(b+\gamma\right)+\gamma\mu}{\Lambda} c - \frac{a\left(b+\gamma\right)\eta}{\Lambda}\varepsilon^h_A$$

$$\tau^*_{i,h} = \left[\frac{a\gamma}{\Lambda} + \frac{\gamma^2\mu^2 b\left[1-\Psi^h_i\right]}{\left(b+\gamma\right)\Lambda}\right]\widetilde{g}_i + \left[\frac{a\gamma}{\Lambda} + \frac{\gamma^2\mu^2 b\left[1-\Phi^h_i\right]}{\left(b+\gamma\right)\Lambda}\right]\delta_i$$
$$- \frac{\gamma\mu\left(1-\theta^h_A+\mu\right)+a}{\Lambda} c + \frac{a\gamma\mu\eta}{\Lambda}\varepsilon^h_A \quad , \ \forall i \in M_h \tag{16}$$
$$= \frac{a\gamma}{\Lambda}\left(\widetilde{g}_i + \delta_i\right) + \frac{\gamma^2\mu^2 b}{\left(b+\gamma\right)\Lambda}\Gamma^h_i - \frac{\gamma\mu\left(1-\theta^h_A+\mu\right)+a}{\Lambda} c + \frac{a\gamma\mu\eta}{\Lambda}\varepsilon^h_A$$

$$g^*_{i,h} = \left[\frac{a\gamma\left(b+\gamma\right)+\gamma\mu^2 b\left[b\Psi^h_i+\gamma\right]}{\left(b+\gamma\right)\Lambda}\right]\widetilde{g}_i - \left[\frac{ab\left(b+\gamma\right)+\gamma\mu^2 b^2\left(1-\Phi^h_i\right)}{\left(b+\gamma\right)\Lambda}\right]\delta_i$$
$$+ \frac{\left(1-\theta^h_A\right) b\mu - a}{\Lambda} c - \frac{ab\mu\eta}{\Lambda}\varepsilon^h_A \quad , \ \forall i \in M_h \tag{17}$$
$$= \frac{a\gamma\left(b+\gamma\right)+\gamma^2\mu^2 b}{\left(b+\gamma\right)\Lambda}\widetilde{g}_i - \frac{ab}{\Lambda}\delta_i + \frac{\gamma\mu^2 b^2}{\left(b+\gamma\right)\Lambda}\left(\widetilde{g}^h_A - \left(\delta_i - \delta^h_A\right)\right)$$
$$+ \frac{\left(1-\theta^h_A\right) b\mu - a}{\Lambda} c - \frac{ab\mu\eta}{\Lambda}\varepsilon^h_A$$

Comparing the terms in *c* in equations (6) and (15) confirms the role of monetary unification as a substitute for domestic central bank independence. Clearly, a positive θ^h_A has the same effect on inflation as a reduction in λ_i. Hence, regional currencies are "better" – i.e. more stable – than national ones, irrespective of member states capacities to build institutions insulated from political influence. Moreover, the stability of the regional currency increases with the size of the union and with the degree of trade integration among its members, as both factors contribute to a higher θ^h_A. Equations (16) and (17) show that monetary unification also leads to adjustments in national fiscal policies with respect to the situation of

monetary autonomy. The reason is that the CCB now determines seigniorage revenues[13] according to union-wide objectives. These modifications have ambiguous welfare effects. On the one hand, the greater monetary discipline resulting from monetary unification drives fiscal variables closer to their second-best levels (as would greater central bank independence, see equations (9) to (12)). On the other hand, cross-country differences in spending objectives and fiscal distortions may induce undesirable deviations from the individually optimal policy mix. This is most likely to be the case for member states with an "extreme" position in the distributions of spending objectives and fiscal distortions because the seigniorage revenues resulting from the common monetary policy will differ the most from their desired levels. These difference are reflected in deviations of Ψ_i^h and Φ_i^h from 1. By contrast, setting $\Psi_i^h = \Phi_i^h = 1$ implies that the policy mix under monetary union is identical to the one under autonomy with a degree of central bank independence $\lambda_i = 1 - \theta_A^h$.

Having obtained closed-form solutions for the time-consistent policy mix under autonomy and monetary union, we can easily derive explicit expressions for the participation constraint of country *i* in a monetary union *h* with membership M_h. Participation will be desirable only if its government can expect to be better-off on average, that is if $E_{-1}G_i(M_h) \equiv E_{-1}U_i^G\big|_{i\in M_h} - E_{-1}U_i^G\big|_{Autonomy} \geq 0$, where E_{-1} is the operator of mathematical expectations taken before stage (i) of the game. Since interpretations of cross-country differences in $\widetilde{g}_i$ and δ_i follow the same logic, we can keep the expression for the expected net utility gain reasonably simple by assuming that $\Psi_i^h = \Phi_i^h$, $\forall i \in M_h$. This is tantamount to say that countries with relatively ambitious spending targets also face relatively large fiscal distortions.

$$
\begin{aligned}
E_{-1}G_i(M_h) = {} & \frac{\theta_A^h\left(2-\theta_A^h\right)(b+\gamma)}{2\Lambda}c^2 \\
& + \frac{\gamma\mu b\left(1-\Psi_i^h\right)\left(\widetilde{g}_i+\delta_i\right)}{\Lambda}\left[\left(1-\theta_A^h\right)c - \frac{\gamma\mu b\left(1-\Psi_i^h\right)\left(\widetilde{g}_i+\delta_i\right)}{2(b+\gamma)}\right], \quad \forall i \in M_h \qquad (18) \\
& - \frac{a^2\eta^2(b+\gamma)\left(1-\omega_i^h\right)^2}{2\Lambda}\left[\sigma_{\varepsilon_i}^2 + \sigma_{\bar{\varepsilon}_{-i}^h}^2 - 2\,\mathrm{cov}\left(\varepsilon_i, \bar{\varepsilon}_{-i}^h\right)\right]
\end{aligned}
$$

[13] We implicitly assume that seigniorage is distributed according to GDP weights, as in the euro area. Although this may not be a Pareto-efficient rule, pragmatism makes it the most likely to be adopted in practice.

where σ_x^2 symbolizes the variance of a random variable *x* and $\bar{\varepsilon}_{-i}^h = \sum_{k \neq i, k \in M_h} \left(\omega_k^h \Big/ 1 - \omega_i^h \right) \varepsilon_k$ (the GDP-weighted average of supply shocks across the $m_h - 1$ other member states of the monetary union) so that $\varepsilon_A^h = \omega_i^h \varepsilon_i + \left(1 - \omega_i^h\right) \bar{\varepsilon}_{-i}^h$.

The first line of the right-hand side of (18) is strictly positive. It captures the unambiguous benefits stemming from a lower inflationary bias. The second line represents the effect of "structural" differences across countries, namely the government's spending objectives and the distortions affecting fiscal policy. Notice that $\tilde{g}_i$ and δ_i end up having exactly the same impact on the gains from monetary unification because both parameters refer to the authorities' incentive to seek larger financing through greater seigniorage and higher tax rates. Interestingly, the welfare effect of those differences is ambiguous and depends upon the fiscal regime of each individual country with respect to those of its partners in the union. Fiscal heterogeneity has two effects on member states' welfare. First, the common inflation rate will only by chance coincide with a member state's individually optimal seigniorage, lowering welfare gains. Second, the fact that the CCB credibly delivers π_h^* is tantamount to say that conflicting demands by individual member states on CCB tend to neutralize one another. Hence, relatively profligate governments ($\Psi_i^h < 1$) will actually benefit from the participation of more fiscally conservative governments because they induce greater discipline on discretionary monetary policy. The opposite is true for fiscally conservative governments ($\Psi_i^h > 1$). The magnitude of these effects on governments' utility declines as the impact of unification on monetary discipline gets larger – witness the presence of $\left(1 - \theta_A^h\right)$.

The third line of (18) is unambiguously negative and accounts for the loss due to suboptimal stabilization of country-specific shocks by the CCB, the core proposition of the theory of optimum currency areas. That term is equal to zero if and only if $\sigma_{\varepsilon_i}^2 = \sigma_{\bar{\varepsilon}_{-i}^h}^2$ and $corr\left(\varepsilon_i, \bar{\varepsilon}_{-i}^h\right) = 1$.

Overall, equation (18) indicates that the decision to participate in a monetary union rests on a trade-off between the benefits of having a supranational currency intrinsically more stable than the national currency and the costs associated with idiosyncrasies.[14] In addition to shock asymmetry, our model emphasizes the differences in the fiscal regime of potential member states – regarding desired government expenditure levels as well as of the overall

[14] In their study of international unions, Alesina, Angeloni and Etro (2003) also note: "*central to the political economy of all unions is the existence of a tension between the heterogeneity of individual countries' preferences and the advantage of taking certain decisions in common.*"

efficiency of fiscal policy. The rest of the paper analyzes the role of that trade-off in shaping the monetary geography of the world.

V. EQUILIBRIUM MONETARY UNIONS

Having established the potential gains from delegating monetary policy to a supranational central bank, a natural question is how individual countries' incentives lead to the formation of monetary unions.[15] The *non-cooperative theory of coalition formation* provides the relevant framework to formally address that issue. Specifically, we analyze the world's monetary geography as the outcome of a game involving simultaneous decisions by individual countries to join a particular union or to retain monetary autonomy. That "monetary integration game" (MIG) takes place *before* the policy game analyzed in sections III and IV and is based on expected pay-offs characterized by equation (18).

Belleflamme (2000) proposes a closely related game in the context of cost-saving agreements among heterogeneous firms, and discusses in detail the theoretical foundations of that type of game.[16] Alesina and Barro (2002) and Di Bartolomeo et al. (2002) apply a similar approach to monetary integration, but with different setups. There are three key differences with Alesina and Barro (2002). First, their monetary integration process is driven by "anchor" countries endowed with an exogenous pre-commitment capacity and acting as catalysts for (and natural hegemons within) currency unions while we allow for monetary unions to be regional and operating on the basis of a cooperative decision process. Second, we explicitly treat fiscal policy and related inefficiencies, an important matter for developing countries considering monetary integration but absent in their paper. Third, they model the trade creation effect attributed to reduced transaction costs within a currency union, an argument that we do not address here given the dynamics it should normally involve (see Yehoue, 2003) and the lesser relevance for most of the "south-south" regional currency unions currently envisaged. Di Bartolomeo et al. (2002) base their study of coalition formation on the pay-offs resulting from a three-country, dynamic AS-AD framework without credibility problems. Also, that paper gives a prominent place to coalitions between monetary and fiscal authorities.

Subsection A describes the MIG and discusses relevant equilibrium concepts. Various equilibrium coalition structures are then characterized in Subsection B, assuming equally sized countries, politically dependent central banks and discretionary fiscal policies. In

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[15] For simplicity, we will abstract from any friction in the formation process, such as negotiation costs and political constraints.

[16] Bloch (2002) also provides a useful survey of the relevant game-theoretic literature. The seminal paper on non-cooperative coalition formation (in the context of cartels) is due to d'Aspremont et al. (1983).

Subsection C, we assess the impact of alternative hypotheses regarding size asymmetries, central bank independence, and restrictions on fiscal discretion. We also discuss different collective decision rules inside the CCB.

A. The Monetary Integration Game

Consider each country's strategic choice either to participate in a specific monetary union or to retain monetary autonomy. Any (pure strategy) equilibrium of the MIG characterizes one possible monetary map of the world (or coalition structure), that is the number and size of currency unions consistent with individual countries incentives. As we deal with a static, *n*-player game of complete information, the Nash equilibrium emerges as the natural equilibrium concept. Hence, the equilibrium coalition structures are such that no individual country has an incentive to deviate ex-ante. In the rest of the paper and in reference to the terminology of d'Aspremont et al. (1983), we define as **stable** any monetary union consistent with a Nash equilibrium of the MIG. This implies three properties (see also Di Bartolomeo et al., 2002).

Property 1

All member states of a stable monetary union h are better-off than under monetary autonomy, that is, $E_{-1}G_i(M_h) \geq 0$, $\forall i \in M_h$.

Understandably, a stable currency union must be profitable for all its members when compared to the alternative of monetary autonomy. Profitability is not sufficient to ensure stable membership. Assuming each country takes the others' strategy as given (Nash conjecture), any MIG's equilibrium is such that no member state would consider joining an alternative monetary union (internal stability) and that no outsider would be better off joining the union (external stability).

Property 2

Assuming that all other member states stay in h, there exists no alternative monetary union s such that at least one member state of h would be better off in that union, that is $\forall k \in M_h$, $\nexists M_s \subset \left((N \setminus M_h) \cup \{k\}\right)$ such that $E_{-1}G_k(M_h) \leq E_{-1}G_k(M_s)$.

Property 3

Assuming that no country leaves h, there exists no outsider country j that would benefit from joining h, that is $\nexists\, j \in (N \setminus M_h)$ such that $E_{-1}G_j\left(M_h \cup \{j\}\right) \geq 0$

From equation (18), it is clear that the benefits from forming a particular union depends on the characteristics of the other countries willing to participate in that same union. In particular, each country gets a different pay-off from joining a given union whereas the gains

of a given country are specific to the union it joins. As observed by Belleflamme (2000), such a game with *asymmetric players and asymmetric associations* is not tractable unless additional simplifications are introduced. In the context of cost-cutting associations by asymmetric firms, he proposes to arbitrarily limit the maximum number of coalitions. Similar restrictions are adopted by Di Bartolomeo et al. (2002), Alesina and Barro (2002) – through their assumption of a limited number of "*anchor currencies*" –, and by Alesina, Angeloni and Etro (2003), who restrict their analysis to unions with same median country.[17] As will be clear below, we also introduce restrictions amounting to cap the number of coalitions emerging in equilibrium – although we do not directly pick the number.

Despite the three properties described above, two clarifications need to be made regarding the stability of coalitions consistent with a Nash equilibrium in this game. First, strategic complementarities in the decisions to participate in a monetary union implies the possibility of profitable exit/entry by *groups* of countries. For example, while it is never optimal for an individual outsider j to join a stable monetary union h alone (by virtue of external stability – Property 3), entry might be profitable if country j were to join along with a group of outsiders. For that to be the case, the disciplinary benefits associated with group entry (mainly through an increase in intra-union trade flows) would have to be large enough to compensate for the costs of idiosyncrasies, a condition that may be satisfied if the coalition of outsiders are sufficiently similar among themselves (both in terms of fiscal regimes and of external shocks) and/or if that coalition as a whole trades a lot with members of h. Should this be the case, both monetary unions (h and the extended one, including the coalition around j) might be deemed stable in the sense defined above. Similarly, member states of stable monetary unions may benefit from a group exit. Clearly, the reason for such behavior is not the "incentive to cheat" found in classic coordination games (see e.g. Hamada, 1985) but in the fact that cross-country heterogeneity leads each individual country to have specific preferences over the membership of the currency union. Specifically, each government realizes it would maximize its utility by joining a union in which it is (slightly) more fiscally profligate[18] than the union's (size-weighted) average. Since the MIG has potentially many Nash equilibria, the industrial organization literature often applies stronger equilibrium concepts, such as the *strong Nash equilibrium* (which excludes all coalitional deviations) and the *coalition-proof Nash equilibrium* (which filters out only credible coalitional deviations). However, these more demanding equilibria do not necessarily exist, and it is unclear why, in the real world, only coalition-proof monetary unions would actually materialize. It therefore makes sense for our purpose to characterize plausible Nash equilibria even though they are associated with a relatively weak notion of coalitional stability.

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[17] They assume majority voting by member governments on common policies.

[18] Observe that, for a given fiscal regime $\left(\widetilde{g}_i, \delta_i\right)$, the gain function (18) is strictly concave in Ψ_i^h with a maximum for $\left|\Psi_i^h\right|^* < 1$, meaning that a specific country maximizes its gains in a union in which its fiscal authorities would be more profligate than the average.

The second caveat related to coalitional stability concerns the time-inconsistency problem of monetary policy. Since the policy mix under a monetary union differs from the individually-optimal (time-consistent) solution under autonomy, member states face an ex-post incentive to quit the union and autonomously revert to the discretionary monetary policy, causing unexpected inflation. This problem is a variant of Mc Callums' (1995) "second fallacy" of central bank independence according to which monetary delegation "merely relocates" the credibility problem of monetary policy into a credibility problem of the institutional framework itself. In line with the related literature, we assume away that possibility, arguing that there exist sufficiently high, exogenous (e.g. political) costs of leaving the union after stage (i) in the policy game.

The next paragraph discusses in greater detail possible configurations of stable monetary unions in our *n*-country world.

B. Monetary Unions Among Countries of Equal Size with Fiscal Heterogeneity

Coalition formation implies that all *n* countries simultaneously announce their decision to be part of a monetary union (or to retain autonomy) and may freely join or leave any coalition (open membership). That "one-shot" approach naturally ignores the dynamic aspects of monetary integration that may be linked to the increase in intra-union trade due to the elimination of certain transaction costs (see for instance Yehoue, 2003).

As already mentioned, cross-country heterogeneity plays a key role in the profitability of monetary unions and will therefore prove critical in their emergence. The model allows for several dimensions in heterogeneity: idiosyncratic shocks, the ambition of public spending targets, the distortions affecting the design of fiscal policy, the size of the economy (output) and the extent of trade integration, all of which could serve as a criterion to designate "similar" or "contiguous" countries. For the sake of tractability, we reduce the heterogeneity to one dimension, and first focus on fiscal heterogeneity, assuming similar sizes, uniform trade integration and uniform shock asymmetry. The latter two assumptions simplifies the discussion by excluding clusters of countries characterized by very similar shocks or very strong integration. Relaxing them has obvious implications that will not be specifically addressed here. The effect of size differences is discussed in Subsection C.

The formal results in this Subsection are derived under the following assumptions or conventions:

(i) $\omega_i = 1/n$, $\forall i \in N \Rightarrow \omega_k^h = 1/m_h \quad \forall k \in M_h$ (countries have the same size; n is an indicator of political fragmentation in the world),
(ii) $(\widetilde{g}_1 + \delta_1) \leq (\widetilde{g}_2 + \delta_2) \leq ... \leq (\widetilde{g}_n + \delta_n)$ (ordering of countries according to their propensity to seek larger financing)

(iii) $\theta_{i,k} = \overline{\theta}/n$ where $\overline{\theta} \in]0;1]$ symbolizes the uniform degree of trade integration $\Rightarrow \theta_i^h = \theta_A^h = (m_h - 1)\overline{\theta}/n$,

(iv) $\sigma_{\varepsilon_i}^2 = \sigma_{\overline{\varepsilon}_{-i}^h}^2 = \sigma^2$ and $corr(\varepsilon_j, \overline{\varepsilon}_{-j}^h) = \rho$, so that $\left(\sigma_{\varepsilon_i}^2 + \sigma_{\overline{\varepsilon}_{-j}^h}^2 - 2\,\mathrm{cov}(\varepsilon_j, \overline{\varepsilon}_{-j}^h) \right) = 2\sigma^2(1-\rho)$ for all i, j and h (uniform asymmetry of shocks across countries).

The predictions of our model regarding the formation of monetary unions are summarized in one Lemma and three Propositions. All proofs are in the Appendix.

Lemma 1: Contiguity

For all $i \in [2, n-1]$, if countries $i-1$ and $i+1$ are members of a stable monetary union h, so is country i. Also, all member states of a stable monetary union have ***contiguous*** *fiscal regimes.*

Lemma 1 underlines the central feature of stable monetary unions in our model, namely the similarity in their fiscal regimes.[19] This leads to the following propositions.

Proposition 1: World currency[20]

If all countries in the world share the same expenditure objectives, face the same fiscal inefficiencies, and are hit by the same shocks (that is $\widetilde{g}_i = \widetilde{g}_j$, $\delta_i = \delta_j$, $\forall i \neq j \in N$ and $\rho = 1$,), then the MIG has a unique Nash equilibrium and N constitutes a stable monetary union. Also, the gains from monetary unification increase with trade integration ($\overline{\theta}$), the effectiveness of monetary policy (c) and political fragmentation (n), and decrease with governments' aversion to inflation (a) and aversion to taxes (b).

If all the countries in the world were identical, the role of monetary unification as a credible substitute for central bank independence would make a world currency desirable. In such a configuration, the loss of monetary autonomy does not entail any cost since, in line with the OCA literature, the common monetary policy optimally responds to everyone's

[19] Other "contiguity" results are found in Alesina and Barro (2002) and Alesina, Angeloni and Etro (2003).

[20] The "grand coalition" is also a feature of industrial-organization problems where firms seeking cost-cutting agreements are symmetric (see Belleflamme, 2000 and Bloch, 2002).

needs. The gains from the single currency stem from the induced monetary discipline, and therefore depend positively on the size of the inflationary bias under autonomy (influenced by *a*, *b* and *c*, see equation (9)) and on the effect of unification on the monetary authorities' incentives to stimulate output beyond its natural level. As noted earlier, trade integration increases the disciplinary gains because the CCB internalizes more externalities. For the same reason, political fragmentation is conducive to greater benefits from monetary unification. Finally, under these conditions, the MIG has a unique Nash equilibrium so that coalition-proofness is not an issue.

The two propositions that follow characterize further the equilibrium monetary geography of the world according to our model.

Proposition 2: Regional currency and fiscal convergence

Given a group of contiguous countries bordered by countries i *and* k*, with* $\tilde{g}_i + \delta_i < \tilde{g}_k + \delta_k$*, there exists a minimum degree of fiscal convergence above which a monetary union (call it* h*) would be profitable for all members of the group. That minimum degree of fiscal convergence is determined by the participation constraint of the most fiscally conservative country, and is given by* $\underline{\Gamma_i^h} < 0$*. The stability of* h *requires* Γ_i^h *to be sufficiently but not too close to* $\underline{\Gamma_i^h}$*. In general,* $\underline{\Gamma_i^h}$ *increases (i.e. fiscal convergence requirements tighten) with shock variability (*σ^2*), the tolerance for accommodative monetary policies in the face of supply shocks (*η*) and the governments' relative aversion to inflation variability (*a*). Also,* $\underline{\Gamma_i^h}$ *decreases with trade integration (*$\bar{\theta}$*) and shock correlation (*ρ*).*

By virtue of Lemma 1, Proposition 2 restricts the attention to groups of fiscally "contiguous" countries as potential candidates for monetary integration. It formally characterizes the minimum degree of fiscal convergence (objectives and overall efficiency of fiscal policy) necessary for a given group to envisage a stable union. Higher (lower) values for $\underline{\Gamma_i^h}$ mean that the group requires tighter (looser) fiscal convergence standards to form a stable monetary union. Importantly, *the most fiscally conservative candidate sets the fiscal convergence standard* because it would be the first one to lose interest in participating (either by staying out or joining another union), should fiscal divergence increase. Remember from our discussion of (18) that its government will indeed suffer the most from pressures exerted by the less conservative member states on the CCB. For a given group of countries, the fiscal convergence requirement will be tighter, the lower the compliance with traditional OCA criteria (witness the effect of shock asymmetry), the smaller the disciplinary benefits from monetary integration (as suggested by the effect of trade integration) and the greater the preference for actively counter-cyclical monetary policies (as indicated by the effect of η). With heterogeneous countries, a world currency union may still be stable provided that fiscal

convergence around the world is strong enough (apply Proposition 2 when $i = 1$ and $k = n$) but it may not be coalition proof.

More likely than a world currency are configurations including regional monetary unions among countries with sufficiently "similar" fiscal regimes. As illustrated by Proposition 3 in the special case of a uniform distribution of fiscal regimes around the world, the number and size of currency unions is determined by the dispersion of fiscal regimes.

Proposition 3: Number and size of stable currency areas

If the fiscal distance between two contiguous countries is constant – i.e., $\forall i \in [1; n-1]$, $\tilde{g}_{i+1} + \delta_{i+1} = (\tilde{g}_i + \delta_i) + \kappa$, *with* $\kappa > 0$, *a constant –, then the world contains either no monetary union or* $\lfloor n/\hat{m} \rfloor$ *stable monetary unions of size* $\hat{m}$. *If two or more countries are left out of a monetary union of size* $\hat{m}$, *they will form a stable "residual" currency union. The relation* $\hat{m}$ *is an integer part function, decreasing in* κ. *Given* κ, $\hat{m}$ *is increasing in the degree of trade integration (*$\bar{\theta}$*) and shock correlation (*ρ*), and decreasing in shock variability (*σ^2*), the tolerance for accommodative monetary policies in the face of supply shocks (*η*), the political fragmentation of the world (*n*) and the governments' relative aversion to missing the inflation target (*a*).*

The comparative static exercise performed on the size of stable monetary unions confirms that the looser the fiscal convergence requirements established by Proposition 2, the greater the size of stable currency unions and the lower the number of currencies in the world. In particular, for given fiscal differences between countries, more synchronized business cycles and greater trade integration are conducive to the formation of larger currency unions, leading to a smaller number of currencies. Conversely, smaller (or no) currency unions and a correspondingly greater number of currencies will emerge if countries are relatively averse to inflation (which tames country-specific credibility problem) and prefer relatively strong monetary responses to supply shocks. Also, political fragmentation is less conducive to the formation of large multilateral currency unions because, for given degrees of fiscal dispersion and trade integration, smaller externalities are internalized. Hence, unless a strongly negative relationship between country size ($1/n$) and trade integration ($\bar{\theta}$) is assumed, the opportunity to form multilateral currency unions does not challenge the positive relationship between the number of countries and the number of currencies (in contrast to Alesina and Barro, 2002).

In the general case in which fiscal distances are uneven, the monetary geography will be shaped according to the clusters of countries in compliance with the minimum degree of fiscal convergence characterized in Proposition 2. We now discuss the implications of alternative hypotheses regarding the size of countries and the role of monetary and fiscal institutions.

C. Extensions: Size Matters, So Do Institutions

Subsection B left aside some important dimensions of heterogeneity that might play a significant role in practice. The first one is that countries willing to form a currency union have different sizes. The second one is the intrinsic capacity of some countries to build credible domestic institutions able to deliver macroeconomic stability, such as independent central banks or enforceable restrictions on fiscal discretion. As already indicated, deriving general results in these cases is difficult, if only because Lemma 1 does not apply anymore. The discussion therefore remains informal although it would be straightforward to illustrate our points with simulations of calibrated versions of the model (see Debrun, Masson and Pattillo, 2003)

Size Matters

Size may affect the results through two channels. The first one concerns the trade patterns between large countries and smaller ones, generally more intense than between two small economies. Our model suggests that, all else equal, large countries are more attractive partners than small countries because their participation in a monetary union means that greater externalities are internalized at once. This effect of size on externalities combines with the greater political influence presumably exerted by large countries on supranational institutions, including the CCB. Therefore, the *joint* distribution of fiscal regimes and country sizes emerges as the critical determinant of the monetary geography. Although large countries may act as natural catalysts for monetary integration (especially if they are more fiscally conservative than the average), they might as well hamper integration if high spending targets and large fiscal inefficiencies lead them to pressure the CCB to extract seigniorage revenues perceived as inefficiently high by their partners in the union.

So the "perfect catalyst" of monetary integration is a large country with a clear revealed preference for fiscal prudence (low $\tilde{g}$) and a proven record of budgetary efficiency (low δ). As shown in Proposition 2 for identically sized countries, the mirror image of fiscally conservative countries' attractiveness to less disciplined partners is their lesser inclination to join multilateral monetary unions unless a minimum degree of fiscal convergence towards their standard of discipline exists. This provides an opportunity for the enforcement of formal fiscal rules (as entry criteria). However, the presumption of irreversible membership clearly challenges the credibility of fiscal restraints once the union is formed. We leave for future research a formal analysis of the potential credibility gains offered by supranational macroeconomic institutions and now turn to the role of institutional heterogeneity among countries.

Institutional Heterogeneity

In practice, countries differ in their individual capabilities to build credible domestic institutions, and in particular independent central banks. Given the role of a supranational central bank as a surrogate for a politically independent central bank at home, one may expect that countries with stronger individual abilities at building discipline-oriented institutions domestically will find less interest in joining a monetary union. To see this, we derive the gain function assuming that individual member states grant some independence to their national central bank and that the CCB has a degree of political independence corresponding to the (size-weighted) average among the union's member states (denoted by λ_A^h). For simplicity, we restrict our attention to the case of fiscally identical countries.

$$E_{-1}G_i(M_h) = \frac{\left(\lambda_i^2 - \left(\theta_A^h - \lambda_A^h\right)^2\right)(b+\gamma)}{2\Lambda}c^2 - \frac{a^2\eta^2(b+\gamma)\left(1-\omega_i^h\right)^2}{2\Lambda}\left[\sigma_{\varepsilon_i}^2 + \sigma_{\bar{\varepsilon}_{-i}^h}^2 - 2\operatorname{cov}\left(\varepsilon_i, \bar{\varepsilon}_{-i}^h\right)\right] \quad (18')$$

It is clear from (18') that countries able to grant some independence to their central banks (i.e. countries with $\lambda_i < 1$) are less interested to participate in a given monetary union. At the limit, if all countries were able to build perfectly credible central banks that implement stability oriented monetary policies ($\lambda_i \to 0$, $\forall i \in N$), no monetary union would ever emerge. This is reminiscent of results previously established by Persson and Tabellini (1996) and Jensen (2000) who showed that a generalized system of inflation targets with independent central banks eliminates any need for international monetary policy coordination.[21]

What do heterogeneous institutional capacities mean for our results? Again, a tension emerges between the low interest of credible countries to join multilateral unions and the attractiveness of those countries for partners with serious credibility problems. The most obvious resolution of that tension lies in the emergence of unilateral currency unions (Alesina and Barro, 2002) in which a number of clients simply adopt the currency of an anchor (i.e. a country characterized by $\lambda_i \to 0$), giving up any influence on their monetary policy. Alternatively, countries may agree to adopt union-wide institutions that look like clones of those in the most disciplined member state. In a model without fiscal policy, Debrun (2001) demonstrates that this will indeed be the case in the Nash bargaining equilibrium of a cooperative game describing negotiations among the potential member states of a monetary union over the institutional features of their CCB.

An important point here is that unilateral currency unions (dollarization) do not preclude the existence of stable, multilateral currency unions elsewhere. One reason is that countries suffering from credibility problems and low institutional capacities may simply not find an

[21] Of course, this is true only for identical preferences and average targets across countries.

anchor that suits their interests, for instance because they trade little with available anchors or because their business cycles are not sufficiently synchronized with the latter to make the adoption of their currency desirable. Another possible consequence of institutional heterogeneity is that an individual country may have an interest in adopting an anchor currency only if its main trading partners simultaneously follow the same strategy. In that case, the formation of a regional union which itself pegs the regional currency to an anchor country (e.g. through a currency board) might be profitable while an individual anchorage might not be so. Yet another possibility is that the constitution of a regional currency area may the starting point of a new anchor currency that would become more attractive because of size effect discussed above. All these configurations are resonating strongly in the real world and could be formally analyzed with calibrated variants of the framework proposed in this paper.

Alternative Decision Rules inside the CCB

Supranational institutions may adopt a variety of collective decision rules corresponding to different vectors of relative weights in equation (13). The latter provides a general description of the contract curve of the cooperative monetary policy game inside the monetary union and can easily accommodate different decision rules. In particular, the hegemonic monetary unions studied by Alesina and Barro (2002) and the majority-rule framework investigated in Alesina, Angeloni and Etro (2003) correspond to specific vectors of ω_i^h. As a result, the functional form of (18) is invariant to the decision rule within the CCB and our analysis could be easily replicated, now highlighting differences of individual countries with respect to the anchor or with respect to the median as the key determinant of the pay-offs from a given monetary union. The spirit of the analysis would nevertheless remain the same.

VI. CONCLUSIONS

Currency unions are fashionable. The successful launch of the euro and the commonly held view that intermediate exchange rate regimes have become harder to implement in a context of increasingly mobile capital have renewed interest in the most extreme form of fixed exchange rate regime. There is hardly a region in the world escaping the debate about the desirability for individual countries either to form a new regional union, to adopt a foreign currency as legal tender or to join an already existing regional union. Remarkably, the debate concerns regions that are often at odds with the traditional view embedded in the classic OCA literature and according to which only highly integrated countries with synchronized business cycles and ample fiscal stabilizers form optimum currency areas. Drawing on the recent literature on European monetary integration, this paper provides a tractable model of monetary union formation emphasizing the role of fiscal distortions and weak institutional capacities (two prominent features of developing economies).

Our analysis leads to two major conclusions. First, stable currency unions can be envisaged for very different groupings of countries that do not necessarily match the typical profile of an optimum currency area as envisioned by the pioneers (Mundell, 1961). In particular, our model suggests that regional monetary unions between low-income, weakly integrated countries such as those of West Africa might be desirable. Second, fiscal convergence and reform emerge as central conditions (along with trade integration and business cycle synchronization) to the emergence of stable currency union, rationalizing the prominence of fiscal entry criteria in the process of monetary integration observed in the European Union and other regions, most notably in West Africa.

Even if monetary geography is likely to be as sluggish as political geography, the next decade may well witness very dramatic changes in international monetary relations. Although the present model validates the view that "fewer monies are better monies" (Dornbush, 2001), it suggests that the reduction in the number of currencies may well materialize through the creation of regional currencies rather than the wider circulation of the three dominant currencies.

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Proof of Lemma 1

Using Property 1, we can write $E_{-1}G_{i-1}(M_h) \geq 0$ and $E_{-1}G_{i+1}(M_h) \geq 0$. To infer the sign of $E_{-1}G_i(M_h)$, we need to know how the gains of a country depends on its position in the distribution of $(\widetilde{g}_i + \delta_i)$. To do so, we look at the sensitivity of the gain function (18) to a change in $(\widetilde{g}_i + \delta_i)$, taking $(\widetilde{g}_A^h + \delta_A^h)$ as given. Differentiating equation (18) twice with respect to $(\widetilde{g}_i + \delta_i)$, we find: $\frac{\partial^2 E_{-1}G_i(M_h)}{\partial(\widetilde{g}_i + \delta_i)^2} = -\frac{[b\gamma\mu]^2}{(b+\gamma)\Lambda} < 0$, which ensures that $E_{-1}G_i(M_h)$ is always greater than either $E_{-1}G_{i-1}(M_h)$ or $E_{-1}G_{i+1}(M_h)$, or both so that $E_{-1}G_i(M_h) \geq 0$ (country i's participation in monetary union h is profitable – Property 1). Since all other parameters in (18) are assumed identical across the member states of h, assuming that country i violates Property 2 and/or Property 3 would contradict the assumption that either country $i-1$ or $i+1$ (or both of them) is a member of a stable monetary union. This ensures that country i satisfies all three properties characterizing members of monetary union h (stable by assumption). That reasoning for country i is valid for all "interior" member states of h, which completes the demonstration.

Proof of Proposition 1

Consider a configuration made of a regional monetary union $M_h \subset N$ and $n - m_h$ countries with autonomous monetary policies. Since for any monetary union $M_s \subset N$, $\Psi_i^s = 1$, $\sigma_{\varepsilon_i}^2 = \sigma_{\varepsilon_j}^2$, and $corr(\varepsilon_i, \bar{\varepsilon}_{-i}^s) = 1$, we can use equation (18) and write:
$E_{-1}G_j\left(M_h \cup \{ j \}\right) = \frac{(m_h\bar{\theta}/n)(2-(m_h\bar{\theta}/n))(b+\gamma)c^2}{2\Lambda} > 0$, $\forall j \in (N \setminus M_h)$, which means that any outsider j would benefit from joining h without inciting any existing member to leave. Hence, monetary union h is not externally stable. The same reasoning can be replicated for any outsider $k \in \left(N \setminus \left(M_h \cup \{ j \}\right)\right)$, so that the only stable monetary union is made of all n countries in the world.

Observe also that each country strictly prefers to participate in the largest possible monetary union since $\forall i \in M_s$ and $\forall M_s \subset N$, $\frac{\partial E_{-1}G_i(M_s)}{\partial m_s} = \frac{\bar{\theta}(b+\gamma)(1-((m_s-1)/n)\bar{\theta})\ c^2}{\Lambda} > 0$, which formally ensures that the equilibrium is coalition-proof.

The comparative static properties of the net gains from a world currency are as follows:

$\frac{\partial E_{-1}G_i(N)}{\partial n} = \frac{\overline{\theta}(b+\gamma)\left(1-((n-1)/n)\overline{\theta}\right)c^2}{n^2\Lambda} > 0$, $\forall i \in N$ (greater political fragmentation increases the gains),

$\frac{\partial E_{-1}G_i(N)}{\partial b} = -\frac{((n-1)/n)\overline{\theta}\left(2-((n-1)/n)\overline{\theta}\right)\gamma^2\mu^2c^2}{2\Lambda^2} < 0$, $\forall i \in N$ (greater aversion to taxes makes monetary union less attractive),

$\frac{\partial E_{-1}G_i(N)}{\partial \overline{\theta}} = \frac{2(b+\gamma)((n-1)/n)\left(1-((n-1)/n)\overline{\theta}\right)c^2}{\Lambda} > 0$, $\forall i \in N$ (greater trade integration increases the gains), and it is immediate to check that, $\forall i \in N$, $\frac{\partial E_{-1}G_i(N)}{\partial c} > 0$ (greater monetary policy effectiveness increases the gains) and $\frac{\partial E_{-1}G_i(N)}{\partial a} < 0$ (greater aversion to inflation reduces the gains).

Proof of Proposition 2

For any country j belonging to the group $[i,k]$, participation in a monetary union h with membership $M_h = \{i, i+1, ..., k-1, k\}$ is profitable if:

$$\begin{aligned}(1/2)((m_h-1)\overline{\theta}/n)\left(2-(m_h-1)\overline{\theta}/n\right)(b+\gamma)c^2 \geq & \\ -b\gamma\mu\left(1-(m_h-1)\overline{\theta}/n\right)c\Gamma_i^h & \\ +\frac{\left(b\gamma\mu\,\Gamma_i^h\right)^2}{2(b+\gamma)} & \\ +a^2\eta^2(b+\gamma)\left((m_h-1)/m_h\right)^2\left[\sigma^2(1-\rho)\right] & \end{aligned} \quad (19)$$

That condition is directly derived from equation (18) (multiplied by Λ and using Γ_i^h instead of Ψ_i^h), with benefits on the left-hand side (LHS) and (potential) costs on the right-hand side (RHS) of the inequality.

By assumption, we have $\Gamma_i^h < 0$ and $\Gamma_k^h > 0$, which implies that, with respect to country k, country i will find participation in h non-profitable for smaller deviations of its fiscal regime from the group average – because the first term of RHS is strictly positive for country

i and strictly negative for country k. Hence, the stability of h can be studied by focusing solely on i. Since the group's composition is given, LHS and $\widetilde{g}_A^h + \delta_A^h$ are constant. Hence, for $\Gamma_i^h < 0$, we have $\partial RHS / \partial \Gamma_i^h < 0$, and there exists a unique $\underline{\Gamma_i^h}$ such that the relation holds with equality and above which participation in h is profitable for country i. Regarding the union's internal stability, the existence of an alternative, profitable monetary union s for country i – with $M_s \subset \left(\left(N \setminus M_h \right) \cup \left\{ i \right\} \right)$ – would require $\Gamma_i^h > \underline{\Gamma_i^h}$ to ensure the stability of h (to see this, subtract $E_{-1} G_i \left(M_s \right) > 0$ from the LHS of (19) evaluated for country i and recall that $\partial RHS / \partial \Gamma_i^h < 0$). External stability requires that country $i-1$ is sufficiently divergent from a fiscal viewpoint and that the entry of $k+1$, if profitable for that country, would imply $\Gamma_i^h < \underline{\Gamma_i^h}$ (forcing country i out of h, in contradiction with the premises of Property 3). This tension between external and internal stability explains why Γ_i^h should be sufficiently but not too close to $\underline{\Gamma_i^h}$. The comparative static properties can be easily derived from (19) and are therefore omitted here.

Proof of Proposition 3

Before developing the straightforward algorithm explaining the formation of stable currency unions, we characterize the marginal gains and losses stemming from a change in the size of a monetary union h bordered by countries i and k in the case of a uniform distribution of fiscal regimes. Following Proposition 2, the stability analysis is based on the utility gains of the most fiscally conservative member state in the union – country i. Since $\widetilde{g}_{i+1} + \delta_{i+1} = \left(\widetilde{g}_i + \delta_i \right) + \kappa$, the function Γ_i^h simplifies as follows:[22]

$$
\begin{aligned}
\Gamma_i^h &= \widetilde{g}_i + \delta_i - \sum_{j \in M_h} \left(m_h \right)^{-1} \left(\widetilde{g}_j + \delta_j \right) \\
&= \widetilde{g}_i + \delta_i - \sum_{j \in M_h} \left(m_h \right)^{-1} \left[\left(\widetilde{g}_i + \delta_i \right) + \left(j - i \right) \kappa \right] \\
&= \widetilde{g}_i + \delta_i - \left(m_h \right)^{-1} \left[m_h \left(\widetilde{g}_i + \delta_i \right) + \frac{m_h \left(m_h - 1 \right)}{2} \kappa \right] \\
&= - \frac{\left(m_h - 1 \right) \kappa}{2} < 0
\end{aligned}
$$

[22] The third step in the calculation follows from a property of arithmetic series: $\sum_{i=0}^{n-1} x + iy = nx + \left(n \left(n-1 \right) y \right) / 2$

We can now evaluate the marginal gain of country i from an enlargement of h to more fiscally profligate outsiders. This is obtained by differentiating the LHS of (19) with respect to m_h.

Marginal gain from enlargement = $(b+\gamma)c^2\frac{\bar{\theta}}{n}\left[1-\left(\frac{m_h-1}{n}\right)\bar{\theta}\right]>0$.

Clearly, the marginal gain from enlargement is decreasing with the size of the union – that is the stock of externalities already internalized.

For country i, there are three sources of utility loss from that enlargement: a lower adequacy of the enlarged union to OCA criteria (third line in the RSH of (19)), an increase in fiscal dispersion (second line), and a decrease in the disciplinary benefits from union membership(first line). Differentiating the RHS of (19) with respect to m_h, we find the respective contributions of those elements to the marginal loss of enlargement for country i:

Marginal loss due to lower OCA adequacy = $2a^2\eta^2(b+\gamma)\sigma^2(1-\rho)\left(\frac{m_h-1}{m_h^3}\right)$

Marginal loss due to greater fiscal dispersion = $\frac{(b\gamma\mu\kappa)^2}{4(b+\gamma)}(m_h-1)$

Marginal loss due to lower discipline = $\frac{b\gamma\mu\kappa}{2}\left[1-\frac{2\bar{\theta}(m_h-1)}{n}\right]c$

In general, it is unclear whether the marginal loss from enlargement is increasing or decreasing with the size of the union. The second derivative of RHS in (19) indeed gives: $\frac{b\gamma\mu\kappa}{2}\left[\frac{b\gamma\mu\kappa}{2(b+\gamma)}-\frac{2\bar{\theta}}{n}c\right]-2a^2\eta^2(b+\gamma)\sigma^2(1-\rho)\left[\frac{2m_h^3-1}{m_h^6}\right]$. However, considering that $\bar{\theta}$ is in practice much smaller than unity (see Debrun, Masson and Pattillo, 2002), that at last count, $n=192$ and that the term in $\sigma^2(1-\rho)$ becomes very small quickly as m_h grows, we may safely conjecture that the marginal loss is increasing in m_h.

We now replicate the simple algorithm proposed by d'Apremont et al. (1983) to find stable coalitions of countries willing to delegate monetary policy to a CCB. Observe first that As a consequence, the reasoning below is valid for any subset of N.

Step 1: Consider the formation of a monetary union between country 1 (the most fiscally conservative in the world) and country 2. If (19) does not hold, then the monetary union between 1 and 2 is not profitable for 1 and it fails to materialize. If the algorithm stops here,

there will be n national currencies in the world. If (19) holds for 1, it also holds for 2 and the union is profitable for both, allowing us to move to step 2.

Step 2: If adding country 3 to the union violates (19) for country 1, then the union $\{1;2\}$ is externally stable (the fact that 1 has to leave would violate the conjecture under which Property 3 operates). That union is also internally stable because country 2 would gain less by forming a monetary union with 3 (in which it would be the most conservative member) and it would prefer autonomy over joining any hypothetical large one. If $\{1;2\}$ is a stable monetary union, we can replicate steps 1 and 2 for countries 3, 4 and 5 because the marginal gains and losses from adding one member state are independent of the level of $\widetilde{g}$ and δ. We could then conclude that $\{3;4\}$ is a stable monetary union. Iterating steps 1 and 2 for all remaining countries in N, we find that in equilibrium, the distribution of fiscal regimes allows for stable monetary unions between two "neighbors" (in the fiscal sense). The resulting equilibrium conjecture is made of $\lfloor n/2 \rfloor$ monetary unions of size 2, with possibly one outsider retaining monetary autonomy. If $\{1;2\}$ is not externally stable, then $\{1;2;3\}$ is profitable for all, allowing us to move to step 3.

Step 3: If adding country 4 implies that (19) is violated for country 1, then $\{1;2;3\}$ is externally stable (see step 2) and also internally stable as country 3 gains more by being the most (fiscally) profligate member state in $\{1;2;3\}$ than the most (fiscally) conservative one in $\{3;4;5\}$ (the only alternative and potentially stable[23] monetary union country 3 could join, by virtue of lemma 1). In that case, the distribution of fiscal regimes allows for stable monetary unions between three "neighbors" (in the fiscal sense) and iterating steps 1 to 3 allows to conclude that the equilibrium configuration is made of $\lfloor n/3 \rfloor$ monetary unions of size 3, with possibly one outsider retaining autonomy or two outsiders forming a "residual" (by definition stable) monetary union.

If the algorithm's last step lies between $n/2$ and $n-2$, then the equilibrium configuration contains two stable monetary unions (although not necessarily coalition-proof) and if it runs until step $n-1$, the equilibrium configuration contains one stable monetary union and one outsider.

It results from the algorithm that the size of stable monetary unions is an integer which depends upon how fast the losses from enlargement catch up with the gains. Differentiating

[23] Given the uniform distribution of fiscal regimes, monetary union $\{3;4\}$ cannot be externally stable if $\{1;2\}$ is not so.

the marginal loss with respect to κ, we find: $\frac{b\gamma\mu}{2}\left[\left[1-\frac{2\bar{\theta}(m_h-1)}{n}\right]c+\frac{b\gamma\mu\kappa}{2(b+\gamma)}(m_h-1)\right]$, which is positive for plausible values of $\bar{\theta}$ and quickly accelerates as the union gets larger, establishing that the size of stable monetary unions decreases (weakly) with fiscal dispersion. The other properties about the size of stable monetary unions are straightforward to derive in the same fashion and are consequently omitted here.