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Currency areas, international monetary regimes, and the employment–inflation tradeoff

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Abstract

We show that the employment–inflation tradeoff facing a central bank depends on the size of the economy for which it sets monetary policy. For inflation-averse central banks, the tradeoff improves the smaller the relevant economy. The tradeoff facing the region whose central bank controls the exchange rate in a managed exchange rate regime does not change moving to a symmetric flexible exchange rate regime. Instead, the core region in an asymmetric regime faces a worse tradeoff than under flexible exchange rates. Equipped with these results, we explore the issue of the optimal size of a currency area both in a two and in a three–region world. © 1998 Elsevier Science B.V.

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1. Introduction

Following the pioneering work of Mundell (1961), the study of currency areas has mainly focused on the structural characteristics of the regions that would join to form such an area, in particular on the degree of labor mobility across regions. This paper addresses a different issue. We ask how the *size* of a currency area and

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the exchange-rate regime which links the area to the outside world affect policy interactions between the area and the rest of the world. Our interest in this question was motivated by the discussions leading to the establishment of An Economic and Monetary Union (EMU) in Europe: for example, how will the working of EMU be affected by its relative size? Will a relatively larger size of EMU be beneficial to the U.S.?

This paper studies the impact of the size of a currency area on the employment–inflation tradeoff facing monetary policymakers in the area and outside, and does so under different assumptions about the exchange-rate regime connecting the currency area and the rest of the world.

We draw on results from the literature on the effects of monetary policy interactions among interdependent economies, originally due to Hamada (1974) and more recently studied in Canzoneri and Henderson (1991). For our purposes, however, these results need to be generalized because they are normally derived under the assumption that countries are of identical size. This hypothesis yields analytically simple models, but obviously allows one neither to study how the relative size of a country affects the constraints facing its authorities and their incentives, nor to thoroughly explore the connections between size and the exchange-rate regime.

Size is obviously irrelevant in extreme cases. For instance, the United States is indifferent as to whether Grenada irrevocably pegs its currency to the dollar, or floats, or pegs but keeps the option to realign the bilateral parity between the East Caribbean dollar and the U.S. dollar. However, the same decision on the part of the UK would not be a matter of indifference for Germany. Countries' preferences over different exchange-rate arrangements do depend on their relative size. Conversely, when the optimal size of a currency area needs to be determined, the exchange-rate regime that will connect the area with the rest of the world may not be a matter of indifference.

In studying the role of the exchange-rate system we focus on the two regimes that more frequently have characterized the international monetary system: floating and managed exchange rates. This is an additional departure from the traditional literature on monetary policy interactions, which normally considers either pure floating or irrevocably fixed rates. A system of credibly and permanently fixed exchange rates is quite different from one in which the central bank pegs its currency to some numeraire, but is free to correct the exchange rate at will—as for example countries other than the United States were allowed to do in the Bretton Woods system, but also in the gold standard as it operated between 1870 and 1913 and, more recently, in the European Monetary System (EMS). Managed rates are distinct from fixed rates and also relatively more frequent.[1]

[1] A regime of managed exchange rates that more closely resembles the *modus operandi* of Bretton Woods is studied in Giavazzi and Giovannini (1989). This article also hints to the fact that a country's incentives may be affected by its relative size, but fails to identify the connections between size, the exchange-rate system, and a country's ranking of alternative international monetary regimes.

When comparing managed and floating rates, it is sometimes argued that peripheral countries (i.e. the countries that in a managed regime maintain control of their bilateral exchange rate vis-à-vis the pivotal currency) prefer managed rates because by setting the exchange rate they can shift abroad the cost of adjusting to an external disturbance, and thus they face a more favourable employment–inflation tradeoff.[2] This paper shows that this intuition is wrong. The employment–inflation tradeoff facing a peripheral country is the same under flexible exchange rates as it is under managed rates. On the contrary, the central country in a managed exchange rate regime (i.e. the country that sets the money supply for all the participants, but looses control of its exchange rate, as did the United States during the Bretton Woods era) always faces a worse tradeoff than under flexible exchange rates, except in the limiting case when the size of the peripheral countries is negligible–like that of Grenada relative to the U.S.

Equipped with our results on the employment–inflation tradeoff facing a region of varying size under alternative exchange-rate regimes, we explore the issue of the optimal size of a currency area. We do this both in a two-region world, in which only the currency area and a peripheral region exist, and in a three-region world, in which the currency area and a periphery interact with the rest of the world. We shall show that enlargement of a currency area to encompass its immediate periphery may be beneficial to the rest of the world.

The paper is organized as follows. In Section 2 we present our work-horse model: a modern two-region version of the time-honored Mundell-Fleming model, as used for example by Canzoneri and Henderson (1991). The behavior of the employment–inflation tradeoffs facing policymakers in different regions is studied in Section 3. Section 4 is devoted to the analysis of the stabilization game induced by a supply-side disturbance which causes inflation and unemployment in each region. In Section 5 we introduce a third region and (in Section 6) we extend the stabilization game accordingly. In Section 7 we draw our conclusions.

2. A two-region model of monetary policy interactions

The world is divided into two regions: we shall refer to them as the ‘‘*core*’’ and the ‘‘*periphery*’’ for reasons that will become apparent when we discuss the working of asymmetric international monetary regimes. We use a standard Mundell-Fleming model, augmented with rational expectations and supply effects. Each region specializes in the production of a single traded good, and the two goods are imperfect substitutes. Output in each region (y^{C}, y^{P}) depends on employment (n^{C}, n^{P}) and on a common productivity disturbance (x):[3]

[2] See for an example Giavazzi and Giovannini (1989).

[3] All variables in the model represent deviations of actual values from zero-shock equilibrium values and, except interest rates, are expressed in logarithms. Time subscripts are dropped whenever possible.

$$y^{j} = (1-\alpha)n^{j} - x \tag{1}$$

where, throughout, the index j = C, P denotes the two regions, core and periphery, and $(1-\alpha)$, with $0<\alpha<1$, the elasticity of output with respect to employment, is the same in both regions. The productivity disturbance is identically and independently distributed with zero mean.

The labor demand of firms is implicit in the following profit maximization condition:

$$w^{j} - p^{j} = -\alpha n^{j} - x \tag{2}$$

Real wages are nominal wages (w^{j}) minus product prices (p_{j}).

Consumer price indexes (q^{j}) are weighted averages of the prices of core's and periphery's goods. Consumers in the core allocate a fraction a of their spending to domestic goods and $(1-a)$ to goods produced by the periphery. The parameter a (which varies between 0 and 1) describes the relative size of the two regions. When a is small, the core is small, while the periphery is large. As a increases, the core becomes larger. When $a=1$, the periphery is reduced to a small open economy, whose policies, as we shall see, do not affect the core. The consumer price index in the core is therefore:

$$q^{C} = ap^{C} + (1-a)(p^{P} - e) = p^{C} - (1-a)z \tag{3}$$

The exchange rate e is the price of the core's currency in terms of the periphery's, and $z = e + p^{C} - p^{P}$ is the real exchange rate between the two regions. Consumers in the periphery are characterized by the same consumption pattern as those in the core, i.e. they allocate a fraction a of their spending to core goods and $(1-a)$ to periphery goods. Hence, the periphery's CPI is:[4]

$$q^{P} = (1-a)p^{P} + a(p^{C} + e) = p^{P} + az \tag{4}$$

Equality between planned and actual expenditures on the two goods requires:

[4]Our assumptions on the trade pattern between core and periphery are consistent with the implicit assumption that consumers in the two regions have identical Cobb-Douglas preferences, which lead to constant shares of income being spent on the various goods according to the assumed pattern. Due to the identity of preferences across regions, the prices of the two consumption baskets are equal when expressed in a common currency, i.e. $q^{C} - q^{P} = -e$.

$$y^{C} = -\delta(1-a)z + \varepsilon[ay^{C} + (1-a)y^{P}] - \nu r,$$
$$y^{P} = \delta az + \varepsilon[ay^{C} + (1-a)y^{P}] - \nu r \tag{5}$$

Residents of each region increase their planned real spending by the same fraction ($0<\varepsilon<1$) of an increase in output. The marginal propensity to spend is equal to the average propensity to spend for all goods, and for residents of all regions. Real depreciation of a currency shifts world expenditure toward that region's good. The effect depends on the elasticity parameter δ and on the size parameter a. When $a=1$, i.e. when the size of the periphery is negligible, a real depreciation of the periphery's currency has no impact on planned expenditure on the core's good, while it has the largest impact on y^{P}. An increase in ex ante real interest rates (r) reduces planned expenditure on both goods: residents of each country decrease spending by the same amount ($0<\nu<1$) for each percentage point increase in the ex ante real interest rate facing them.

Ex ante real interest rates are:

$$r^{j} = i^{j} - E(q^{j}_{+1}) + q^{j}, \tag{6}$$

where i^{C} and i^{P} are nominal interest rates on bonds denominated in core's and periphery's currency, respectively, and $E(q^{j}_{+1})$ is the expected value of region j's CPI one period ahead, based on the information currently available.[5]

Bonds denominated in the two currencies are perfect substitutes, and the arbitrage condition is:

$$i^{C} = i^{P} - E(e_{+1}) + e. \tag{7}$$

While residents of each region hold both regions' bonds, they only hold domestic money. Demands for real money balances are given by:

$$m^{j} - p^{j} = y^{j} - \lambda i^{j}, \tag{8}$$

where λ is the interest-rate semi-elasticity of demand for real money balances.

Substituting Eqs. (1) and (2) into the demands for real money balances, we can express labor demand as:

$$n^{j} = m^{j} - w^{j} + \lambda i^{j}, \tag{9}$$

Because λ is positive, an increase in interest rates raises labor demand. This is a consequence of the money market equilibrium condition. Holding m and p constant, if i increases, a higher y—and consequently n—is required to restore equilibrium.

Nominal wages are predetermined according to contracts signed before the

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[5] Real interest rate terms in Eq. (5) can be written as $ar^{C}+(1-a)r^{P}$, since agents can borrow in both regions. Perfect capital mobility and identity of the consumption patterns across regions imply real interest rate equalization, so that $r^{C}=r^{P}=r$.

beginning of the current period by competitive unions and firms. The wage setting rule is derived from the assumption that unions choose nominal wages to minimize the expected deviations of employment and real wage from equilibrium values, subject to the constraint given by Eq. (9). Hence, unions solve:

$$\min_{w^j} \frac{1}{2}\{\omega E_{-1}[(m^j - w^j + \lambda i^j)^2] + (1-\omega)E_{-1}[(w^j - q^j)^2]\},\ 0 < \omega < 1.$$

The first-order condition yields:

$$w^j = \omega E_{-1}(m^j + \lambda i^j) + (1-\omega)E_{-1}(q^j) \tag{10}$$

Nominal wages are thus a weighted average of the expected indicators of the central bank's monetary stance—money supply and interest rate—and of the CPI.

We focus on the effects of international interactions, neglecting the time inconsistency problems that may arise within each region in the interaction between the authorities and the private sector. We also assume that random supply disturbances are unexpected. These assumptions imply that the rationally expected values of all variables coincide with their no-disturbance equilibrium values, i.e. zero, so that the wage setting rule simplifies to:

$$w^j = 0, \tag{10$'$}$$

which in turn implies the following expressions for employment and producer prices:

$$n^j = m^j + \lambda i^j,$$

$$p^j = \alpha n^j + x \tag{11}$$

Central banks minimize the following loss functions:

$$L^{CB^j} = \frac{1}{2}[\gamma(q^j)^2 + (1-\gamma)(n^j)^2],\ 0 < \gamma < 1 \tag{12}$$

where γ measures the weight the authorities attach to inflation relative to employment.[6]

The instruments available to central banks depend on the exchange-rate regime between the core and the periphery. We compare two different monetary regimes: an asymmetric regime (*managed exchange rates*) in which the core's central bank sets the money supply, while the periphery's central bank sets the value of the bilateral exchange rate, and a symmetric regime (*flexible exchange rates*), in which each central bank sets its own money supply. In both cases we assume that

[6]Because we want to focus on strategic interactions per se and on the role of size and exchange-rate regime, we assume that policymakers' preferences are identical across regions and free of time-inconsistency problems.

monetary policies are set non-cooperatively, i.e. we limit the analysis to the case of Nash equilibria.[7]

In the reduced form solution of the model—whose derivation we omit for brevity—endogenous variables in each region are linear functions of the policy instruments and of the disturbance. Hence, when $x=0$, zero values of the instruments ensure zero losses for all authorities. This proves the rationality of static expectations under the assumption that disturbances have zero mean.[8]

The reduced forms for employment and the CPI in each region *under managed exchange* rates can be written as:

$$
\begin{aligned}
q^{C} &= Am^{C} - B(1-a)e + \Sigma x \\
q^{P} &= Am^{C} + [1 - B(1-a)]e + \Sigma x \\
n^{C} &= \Lambda m^{C} + \Delta(1-a)e - Hx \\
n^{P} &= \Lambda m^{C} + (\Omega - \Delta a)e - Hx
\end{aligned} \tag{13}
$$

Upper-case Greek letters denote parameters that are functions of the structural parameters of the model. Reduced form parameters have been written so as to highlight the effect of changes in the relative size of the region on the elasticity of endogenous variables with respect to the policy instruments. When $a=1$, i.e. if the periphery is a small open economy, changes in the exchange rate do not affect the core economy. Besides, when $a=1$, e has a one-to-one impact on the periphery's CPI, q^{P}.

Reduced forms *under flexible exchange rates* are:

$$
\begin{aligned}
q^{C} &= [A + E(1-a)]m^{C} - E(1-a)m^{P} + \Sigma x \\
q^{P} &= (A + Ea)m^{P} - Eam^{C} + \Sigma x \\
n^{C} &= [\Lambda - \Gamma(1-a)]m^{C} + \Gamma(1-a)m^{P} - Hx \\
n^{P} &= (\Lambda - \Gamma a)m^{P} + \Gamma am^{C} - Hx
\end{aligned} \tag{14}
$$

As above, if the periphery is a small open economy, its policy choices have no

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[7] Our interpretation of a managed exchange rate regime implicitly focuses on the choice of the central parity between the two currencies rather than of the daily exchange rate. In some instances of managed exchange rate regimes, for example in the EMS, assuming that realignments are non-cooperative may be too strong. However cooperation in the form of joint minimization of the central banks' loss functions, as usually assumed in the literature, is even more extreme

[8] The assumption that $E(\cdot_{+1})=0$ rules out speculative bubbles. See Ghironi and Giavazzi (1998) for details on the solution of the model.

impact abroad. Also, when the two regions have equal size ($a=0.5$), symmetry of the exchange-rate regime implies symmetric reduced forms. Under both exchange-rate regimes, and irrespective of region size, a positive realization of x causes inflation and unemployment in both regions. Our choice of focusing only on central banks' reactions to supply disturbances, thus neglecting other types of shocks, is motivated precisely by the fact that the former are the most typical example of shocks that present policymakers with a tradeoff between inflation and employment stabilization. A monetary contraction aimed at stabilizing inflation further decreases employment, whereas a monetary expansion designed to boost employment has inflationary consequences. Understanding the determinants of a region's employment–inflation tradeoff is thus important for analyzing the making of monetary policy in the region.

3. Size, international monetary regimes, and the employment–inflation tradeoff

In this section we study how the employment–inflation tradeoff facing the central bank of a region is affected by the region's relative size under alternative exchange-rate regimes.

First, we show that *the tradeoff facing the periphery under managed exchange rates* becomes steeper as the size of that region gets smaller. A steeper tradeoff allows the central bank to trade a larger inflation gain for a smaller employment loss. If the central bank is sufficiently averse to inflation, a steeper tradeoff is also a more favourable one. Thus, when we argue that a steeper tradeoff is better, we are implicitly assuming that central banks care more about inflation than about employment in their loss functions, i.e. that $\gamma>0.5$.[9]

The following intuitive argument allows to show that $\partial q^{\mathrm{P}}/\partial n^{\mathrm{P}}$ is an increasing function of a, i.e. that the output loss for any given reduction in the CPI falls as the size of the region becomes smaller. From Eq. (13):

$$\frac{\partial q^{\mathrm{P}}}{\partial n^{\mathrm{P}}}\equiv\frac{\partial q^{\mathrm{P}}/\partial e}{\partial n^{\mathrm{P}}/\partial e}=\frac{1-B(1-a)}{\Omega-\Delta a}$$

The numerator of this expression is an increasing function of a: as the periphery becomes small, and correspondingly reduces its consumption of domestic goods, its CPI increasingly depends upon the price at which periphery residents can buy foreign products, i.e. on the exchange rate. In the limit case in which $a=1$, the

[9] If the central banks attached a larger weight to employment than to inflation, a flatter tradeoff would be more favourable, as it would allow to trade larger employment gains for smaller inflation losses. Our assumption implies that central banks will react to a positive realization of x by contracting monetary policy.

periphery consumes only foreign goods and e has a one-to-one impact on q^{P}. To complete the proof, it is sufficient to show that the denominator of the above expression is a decreasing function of a. The argument runs as follows. From Eq. (11), $n^{\mathrm{P}}=m^{\mathrm{P}}(e)+\lambda i^{\mathrm{P}}$, where m^{P} depends on e through the endogeneity constraint imposed by the managed exchange rate regime. This constraint has the form $m^{\mathrm{P}}=m^{\mathrm{C}}+(1/\eta)e$, where η is a parameter independent of a. Hence, the impact of e on n^{P} varies with the size of the periphery because the impact of e on i^{P} depends on a.

Using the uncovered interest parity condition Eq. (7) allows us to write $i^{\mathrm{C}}-e=i^{\mathrm{P}}\}$. Therefore:

$$\frac{\partial i^{\mathrm{C}}}{\partial e}de - de = \frac{\partial i^{\mathrm{P}}}{\partial e}de$$

When $a=1$, changes in e have no impact on foreign variables, so that $\partial i^{\mathrm{P}}/\partial e=-1$, and $\partial n^{\mathrm{P}}/\partial e=(1/\eta)-\lambda$. For $a<1$, we have: $\partial n^{\mathrm{P}}/\partial e=(1/\eta)+\lambda(\partial i^{\mathrm{C}}/\partial e-1)$. In order for this expression to be greater than the corresponding expression evaluated at $a=1$, it has to be $\partial i^{\mathrm{C}}/\partial e>0$.[10] The absolute value of $\partial i^{\mathrm{C}}/\partial e$ is intuitively decreasing in a, because the impact of the periphery on the core is smaller the larger the core. Showing that $\partial i^{\mathrm{C}}/\partial e>0$ would conclude the proof, since it would imply that $\partial n^{\mathrm{P}}/\partial e$ decreases as the size of the core increases. Because $\partial i^{\mathrm{C}}/\partial e=1+(\partial i^{\mathrm{P}}/\partial e)$, $\partial i^{\mathrm{C}}/\partial e>0$ if and only if $\partial i^{\mathrm{P}}/\partial e>-1$. But $a=1$ is the situation in which changes in e have the greatest impact on the periphery's nominal variables: in such a situation $\partial i^{\mathrm{P}}/\partial e=-1$. Therefore, $\partial i^{\mathrm{P}}/\partial e$ cannot decrease below -1 and is strictly above if $a<1$, which completes our proof that the tradeoff for the region which controls the exchange rate improves as its size gets smaller.

To further understand why, when $a<1$, $\partial i^{\mathrm{C}}/\partial e>0$, observe that, in general, the uncovered interest parity condition implies $i^{\mathrm{P}}-i^{\mathrm{C}}=E(e_{+1})-e$. For any given value of $E(e_{+1})$, if e decreases, the expected depreciation of the periphery's currency increases, and so does the interest rate differential, $i^{\mathrm{P}}-i^{\mathrm{C}}$, to preserve portfolio equilibrium. Unless the size of the periphery is negligible, $i^{\mathrm{P}}-i^{\mathrm{C}}$ widens when e decreases because interest rates fall in the core and rise in the periphery. The point is that a larger expected depreciation makes the periphery's bonds less attractive. Investors substitute away from the periphery's bonds into the core's. Hence the price of the former decreases, so that i^{P} increases, and the price of the latter increases, so that i^{C} decreases. If $a=1$, holdings of core's bonds relative to periphery's bonds do not change and $\partial i^{\mathrm{C}}/\partial e=0$.

[10] The sign of $(1/\eta)-\lambda$ is ambiguous, but this is irrelevant for our proof because, recalling that $\lambda>0$:

$$\frac{1}{\eta}+\lambda\left(\frac{\partial i^{\mathrm{C}}}{\partial e}-1\right)>\frac{1}{\eta}-\lambda\Leftrightarrow\lambda\frac{\partial i^{\mathrm{C}}}{\partial e}-\lambda>-\lambda\Leftrightarrow\frac{\partial i^{\mathrm{C}}}{\partial e}>0,$$

regardless of the sign of $(1/\eta)-\lambda$.

To summarize, the employment–inflation tradeoff facing the periphery under managed exchange rates steepens, as the size of the periphery becomes smaller, for two reasons. First, due to our assumptions about the pattern of trade, a relatively smaller periphery consumes more goods produced in the core: thus, the fall of the CPI induced by (say) an exchange rate appreciation is larger. At the same time, the impact of the appreciation on employment becomes smaller because interest rates in the core are less affected, while i^{P} rises by more, thus reducing the fall in employment required to restore equilibrium in the money market.[11] This result is illustrated in Fig. 1, which shows the employment–inflation tradeoff facing the periphery for two values of a. The steeper line corresponds to the case where the core is relatively large, and the periphery is relatively small; along this line the tradeoff is also more favourable if the central bank is averse to inflation.

We next consider how size affects *the periphery's tradeoff under flexible exchange rates*. One might expect that for any given relative size the tradeoff depends on the monetary regime. This is not true: we shall show that for any given relative size, the periphery faces the same tradeoff independently of the exchange-rate regime.

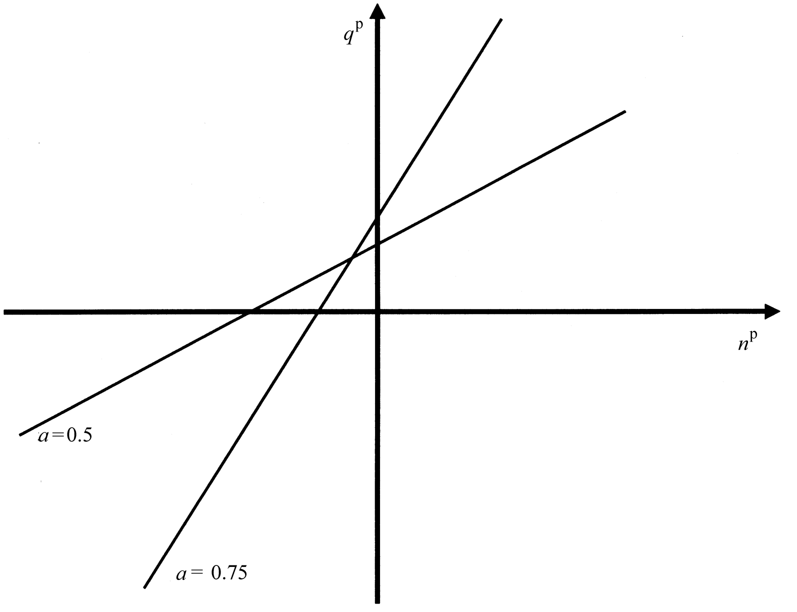

Fig. 1. The employment–inflation tradeoff of the periphery.

[11] Recall that a nominal appreciation implies a decrease in m^{P} via the managed exchange rates constraint.

We start by showing that also under flexible exchange rates the periphery's tradeoff improves as its relative size shrinks. The proof runs as follows. Using Eq. (11), combined with the uncovered interest parity condition, and recalling that under flexible exchange rates $e=\eta(m^{P}-m^{C})$, we obtain:

$$\frac{\partial n^{P}}{\partial m^{P}}=1+\lambda\frac{\partial i^{P}}{\partial m^{P}}=1+\lambda\left(\frac{\partial i^{C}}{\partial m^{P}}-\frac{\partial e}{\partial m^{P}}\right)=1+\lambda\left(\frac{\partial i^{C}}{\partial m^{P}}-\eta\right)$$

$$\frac{\partial n^{P}}{\partial e}=\frac{1}{\eta}+\lambda\left(\frac{\partial i^{C}}{\partial e}-1\right)=\frac{1}{\eta}+\lambda\left(\frac{\partial i^{C}}{\partial m^{P}}\frac{\partial m^{P}}{\partial e}-1\right)$$

$$=\frac{1}{\eta}+\lambda\left(\frac{\partial i^{C}}{\partial m^{P}}\frac{1}{\eta}-1\right)$$

Hence:

$$\frac{1}{\eta}\frac{\partial n^{P}}{\partial m^{P}}=\frac{1}{\eta}+\lambda\left(\frac{\partial i^{C}}{\partial m^{P}}\frac{1}{\eta}-1\right)=\frac{\partial n^{P}}{\partial e}$$

We have shown above that $\partial n^{P}/\partial e$ decreases as a increases: it follows that $\partial n^{P}/\partial m^{P}$ is also a decreasing function of a. What remains to be shown is that $\partial q^{P}/\partial m^{P}$ is instead an increasing function of a, which would allow us to argue that the periphery's tradeoff under the symmetric regime, $\partial q^{P}/\partial n^{P}\equiv(\partial q^{P}/\partial m^{P})/(\partial n^{P}/\partial m^{P})$, improves when the core gets larger. From Eq. (4), the periphery's CPI is $q^{P}=p^{P}+az$. Therefore:

$$\frac{\partial q^{P}}{\partial m^{P}}=\frac{\partial p^{P}}{\partial m^{P}}+a\frac{\partial z}{\partial m^{P}}$$

$$\frac{\partial q^{P}}{\partial e}=\frac{\partial p^{P}}{\partial e}+a\frac{\partial z}{\partial e}$$

Multiplying both sides of the second equation by $\partial e/\partial m^{P}$, we have:

$$\frac{\partial q^{P}}{\partial e}\frac{\partial e}{\partial m^{P}}=\frac{\partial p^{P}}{\partial m^{P}}+a\frac{\partial z}{\partial m^{P}}=\frac{\partial q^{P}}{\partial m^{P}}$$

But, $\partial e/\partial m^{P}=\eta$, so that $\partial q^{P}/\partial e=(1/\eta)(\partial q^{P}/\partial m^{P})$. Since $\partial q^{P}/\partial e$ has been shown above to be an increasing function of the size of the core, bounded above by 1 when $a=1$, it follows that $\partial q^{P}/\partial m^{P}$ is also an increasing function of a. This completes the proof that also under flexible exchange rates the periphery's tradeoff improves as its size becomes smaller.

But we shall also show that this tradeoff is unchanged across exchange-rate regimes, irrespective of the value of a. Using the result we have just derived, and recalling that $\partial n^{P}/\partial e=(1/\eta)(\partial n^{P}/\partial m^{P})$, we obtain:

$$\frac{\partial q^{P}/\partial e}{\partial n^{P}/\partial e}=\frac{(1/\eta)(\partial q^{P}/\partial m^{P})}{(1/\eta)(\partial n^{P}/\partial m^{P})}=\frac{\partial q^{P}/\partial m^{P}}{\partial n^{P}/\partial m^{P}}$$

which proves our point.

Thus far, we have considered the tradeoff faced by the periphery. What about *the core region*? Note first that when the international monetary regime is asymmetric—and the periphery controls the bilateral exchange rate—the core, contrary to the periphery, always faces the same employment–inflation tradeoff, independently of its size. This is apparent if we observe that in the asymmetric regime the reduced forms imply: $\partial q^{C}/\partial n^{C} \equiv (\partial q^{C}/\partial m^{C})/(\partial n^{C}/\partial m^{C}) = A/\Lambda$ where A and Λ are a-invariant parameters. When instead the exchange-rate regime is symmetric, the definitions of ''core'' and ''periphery'' become arbitrary. Hence, if—as we have shown, the periphery faces the best tradeoff when it is small, if we switch the names and we call ''core'' the region that was previously ''periphery'' and vice versa, it follows that also the core faces the best tradeoff when it is small and both regions face identical tradeoffs when they are exactly identical ($a=0.5$). When $a=1$ the core faces the same tradeoff it would face under the asymmetric regime, as the reader can easily check. The intuition is straightforward: when the periphery is a small open economy, it has no impact on the core economy. Therefore, the tradeoff facing the core must be unaffected by the exchange-rate regime.

The common intuition which underlies our results is that the tradeoff facing a central bank depends on the size of the region for which the central bank sets its instrument.[12] In the case of the periphery this size is independent of the exchange-rate regime: the central bank of the periphery always sets its instrument only for its own economy, independently of the exchange-rate regime. This is not the case for the core. Under flexible exchange rates the core central bank sets the money supply only for the core itself, but in the managed exchange rate regime the central bank of the core sets money supply for the entire world: this is because, for any given value of the exchange rate, the central bank of the periphery perfectly accommodates any change in the core's money supply. Thus, the economy that is relevant to determine the tradeoff facing the core central bank is the entire world, core plus periphery, regardless of the relative size of the two economies. Changing the exchange-rate regime changes the size of the economy for which the core central bank sets its instrument; this does not happen in the periphery.

The more favourable the tradeoff a region faces relative to its neighbours, the larger the amount of inflation that such a region can shift upon them, independently of the exchange-rate regime.[13] In an asymmetric exchange-rate regime the periphery always faces a better tradeoff than the core regardless of its relative size, because, when the regime is asymmetric, the core faces the worst possible tradeoff. In contrast, in a symmetric regime, the region facing the best tradeoff is

[12] More in general, the tradeoff depends on a set of structural characteristics of the region, not only its size.

[13] Of course, if the region that exports inflation is much smaller than that which suffers the consequences of its partner's beggar-thy-neighbour policy, the impact of exported inflation on the latter economy will be correspondingly reduced.

the one whose relative size is smaller. One implication is that, if the exchange-rate regime is asymmetric, the periphery can export inflation to the core also when $a = 0.5$. When exchange rates are flexible, the periphery can manage to export inflation only if it is smaller than the core.

How does this result compare with the literature on monetary policy interactions under alternative exchange-rate regimes? Giavazzi and Giovannini (1989) argue that in a managed exchange rate regime the employment–inflation tradeoff facing the country which controls the exchange rate is superior to that facing the country which sets the world-wide money supply. The intuition is that this happens because, in an asymmetric exchange-rate regime, the country which controls the exchange rate can improve its tradeoff by exporting inflation abroad via an exchange rate appreciation. But if this interpretation were correct, one would expect the periphery to face a better tradeoff under managed exchange rates than under flexible rates independently of its size, which, as we have shown, is not true.[14] The correct way to think about the result is that countries successfully run beggar-thy-neighbour policies when their (more favourable) tradeoffs allow them to do so, which is different from thinking that countries face more favourable tradeoffs because they successfully run beggar-thy-neighbour policies. The result presented in Giavazzi and Giovannini (1989) according to which the central bank of the core ranks flexible exchange rates above managed exchange rates unless its size is much bigger than that of the periphery can now be reinterpreted correctly as follows. For any value of a smaller than one, the core faces a better tradeoff under flexible exchange rates than in an asymmetric regime. Instead, when $a = 1$, the tradeoff facing the core is the same irrespective of the exchange-rate regime.

4. Monetary policy interactions in a two-region world

Having established how the employment–inflation tradeoff facing a region depends on its relative size and on the exchange-rate regime, we now study the stabilization game induced by a world-wide supply-side disturbance which causes inflation and unemployment. We investigate how the equilibrium is affected by changes in the relative size of core and periphery, that is by changes in a. The analysis of Section 3 focused almost entirely on the structural features of the two economies. The behavior of a region's tradeoff was determined independently of the policymaker's preferences. These mattered only insofar as we assumed central banks to be relatively more concerned about inflation. Here, both structural constraints *and* policymakers' preferences become relevant in determining the

[14] Although it is true that if the periphery's central bank controls the exchange rate—and thus the inflation differential $q^P - q^C$ (see Eq. (13))—the central bank of the periphery will affect the position of its tradeoff *relative* to that of the core by ''driving'' the latter to the worst situation under flexible exchange rates.

results, because central banks minimize the respective loss functions subject to the constraints given by the tradeoffs they face.

Using the results derived in Section 3, the reduced form equations for employment and the CPIs can be rewritten in a way that shows more explicitly the impact of the regions' relative size and of the exchange-rate regime:

(i) *managed exchange rates:*

$$q^{\mathrm{C}} = Am^{\mathrm{C}} - \left(1 - \frac{A}{\eta}\right)(1-a)e + \Sigma x$$

$$q^{\mathrm{P}} = Am^{\mathrm{C}} + \left[a + \frac{A}{\eta}(1-a)\right]e + \Sigma x$$

$$n^{\mathrm{C}} = \Lambda m^{\mathrm{C}} + \Delta(1-a)e - Hx$$

$$n^{\mathrm{P}} = \Lambda m^{\mathrm{C}} + \left(\frac{\Lambda}{\eta} - \Delta a\right)e - Hx \tag{13$'$}$$

(ii) *flexible exchange rates:*

$$q^{\mathrm{C}} = [Aa + \eta(1-a)]m^{\mathrm{C}} - (\eta - A)(1-a)m^{\mathrm{P}} + \Sigma x$$

$$q^{\mathrm{P}} = [A(1-a) + \eta a]m^{\mathrm{P}} - (\eta - A)am^{\mathrm{C}} + \Sigma x$$

$$n^{\mathrm{C}} = [\Lambda - \eta\Delta(1-a)]m^{\mathrm{C}} + \eta\Delta(1-a)m^{\mathrm{P}} - Hx$$

$$n^{\mathrm{P}} = [\Lambda - \eta\Delta a]m^{\mathrm{P}} + \eta\Delta am^{\mathrm{C}} - Hx \tag{14$'$}$$

In the non-cooperative managed exchange rate regime the central bank of the core region picks the money supply which minimizes its loss function taking the exchange rate as given. Instead, the central bank of the periphery, on the contrary, uses the exchange rate as its instrument taking the money supply of the core as given. Therefore, the first-order conditions of the two central banks are:

$$\gamma q^{\mathrm{C}} \frac{\partial q^{\mathrm{C}}}{\partial m^{\mathrm{C}}} + (1-\gamma)n^{\mathrm{C}} \frac{\partial n^{\mathrm{C}}}{\partial m^{\mathrm{C}}} = 0 \tag{15}$$

$$\gamma q^{\mathrm{P}} \frac{\partial q^{\mathrm{P}}}{\partial e} + (1-\gamma)n^{\mathrm{P}} \frac{\partial n^{\mathrm{P}}}{\partial e} = 0 \tag{16}$$

In the non-cooperative flexible exchange rate regime both central banks use money supply as their instrument, taking their counterpart's money supply as given. In this case the first-order conditions for both central banks are as in Eq. (15). The cost of relaxing the assumption of symmetric regions becomes apparent here: when the relative size of the two regions can differ, it becomes impossible to obtain an easily interpretable analytical solution for the equilibrium of the stabilization game. Nonetheless, it turns out that we can interpret the impact of small changes in the value of a on the equilibrium of the game without having to explicitly solve the game. The argument relies on the results obtained in Section 3.

4.1. Small changes in relative size

The first-order conditions of the central banks' minimization problem can be written as:

$$\frac{\tilde{q}}{\tilde{n}} = -\frac{1-\gamma}{\gamma\tau} \tag{17}$$

where $\tilde{q}$ and $\tilde{n}$ are the (Nash) equilibrium values of CPI and employment, τ is the value of the employment–inflation tradeoff facing the central bank as defined in Section 3, i.e. $\tau \equiv (\partial q/\partial\ \textit{instrument})/(\partial n/\partial\ \textit{instrument})$, and country superscripts are omitted. Eq. (17) states that knowledge of the tradeoff facing a central bank and of the relative weight that the latter attaches to the two targets in its loss function is sufficient to determine the equilibrium value of the inflation–employment *ratio*. In other words, this is determined irrespective of the equilibrium values of the policy instruments. The levels of inflation and employment will be determined by the values of the instruments, but the ratio among them is only determined by the structural characteristics of the economy for which a central bank sets monetary policy and by its preferences.

From Eq. (17), it follows that the effect of a change in a on the equilibrium value of the inflation–employment ratio is described by:

$$\frac{\partial(\tilde{q}/\tilde{n})}{\partial a} = \frac{1-\gamma}{\gamma\tau^2}\frac{\partial\tau}{\partial a} \tag{18}$$

Given the central bank's map of indifference curves in the (n, q) space, whose shape is determined by γ, changes in a affect the equilibrium value of the inflation–employment ratio through their impact on the tradeoff facing the central bank. This result can be used to interpret the consequences of changes in the relative size of the two regions, a, on the outcome of the stabilization game. Consider the periphery first.

We have shown in Section 3 that the tradeoff facing the periphery's central bank under both exchange-rate regimes is an increasing function of a. A steeper tradeoff causes the ratio of the equilibrium values of inflation and employment to increase. Starting from a negative value of the ratio, the latter being an increasing function of τ means that the absolute value of the ratio will become smaller, i.e. the absolute value of $\tilde{q}/\tilde{n}$ decreases in the periphery as a rises. The central bank's loss function, evaluated at the equilibrium, can be written as:

$$\tilde{L} = \frac{\tilde{n}^2}{2}\left[\gamma\left(\frac{\tilde{q}}{\tilde{n}}\right)^2 + 1 - \gamma\right] \tag{19}$$

Differentiating this expression with respect to a gives:

$$\frac{\partial \tilde{L}}{\partial a} = \tilde{n}\,\frac{\partial \tilde{n}}{\partial a}\left[\gamma\left(\frac{\tilde{q}}{\tilde{n}}\right)^2 + 1 - \gamma\right] + \gamma\tilde{n}\tilde{q}\,\frac{\partial(\tilde{q}/\tilde{n})}{\partial a} \tag{20}$$

Because the product of $\tilde{q}$ and $\tilde{n}$ is negative and $\tilde{q}/\tilde{n}$ increases with a, the second term in this expression is unambiguously negative (and larger the larger is γ). The term in square brackets is unambiguously positive. Under the managed exchange rate regime,

$$\frac{\partial \tilde{n}^{\mathrm{P}}}{\partial a} = \Lambda\,\frac{\partial \tilde{m}^{\mathrm{C}}}{\partial a} + \left(\frac{\Lambda}{\eta} - \Delta a\right)\frac{\partial \tilde{e}}{\partial a} - \Delta\tilde{e}$$

Appealing to the envelope theorem, we can assume that the effects of *small* changes in a on the optimal values of the economic policy instruments are small, and conclude that:

$$\frac{\partial \tilde{n}^{\mathrm{P}}}{\partial a} \cong -\Delta\tilde{e} > 0$$

because a sufficiently inflation-averse central bank reacts to the consequences of the shock by appreciating the exchange rate. Under flexible exchange rates:

$$\frac{\partial \tilde{n}^{\mathrm{P}}}{\partial a} = (\Lambda - \eta\Delta a)\,\frac{\partial \tilde{m}^{\mathrm{C}}}{\partial a} + \eta\Delta a\,\frac{\partial \tilde{m}^{\mathrm{P}}}{\partial a} - \eta\Delta(\tilde{m}^{\mathrm{P}} - \tilde{m}^{\mathrm{C}})$$

or, assuming that changes in the equilibrium values of policy instruments are small,

$$\frac{\partial \tilde{n}^{\mathrm{P}}}{\partial a} \cong -\eta\Delta(\tilde{m}^{\mathrm{P}} - \tilde{m}^{\mathrm{C}})$$

which is positive for a greater than 0.5 since the periphery's central bank chooses a more aggressive contraction than the core's when it faces a relatively more favourable tradeoff. Hence, a negative value of $\tilde{n}$ ensures that also the first term in Eq. (20) is negative, so that the periphery's central bank unambiguously benefits from facing a steeper tradeoff. The intuition is that, under both regimes, an improvement in the tradeoff allows the periphery's central bank to achieve better stabilization of both inflation and employment, with a declining absolute value of $\tilde{q}/\tilde{n}$.

What happens in the core?

If the exchange-rate regime is asymmetric, a change in a does not affect the tradeoff facing the core's central bank and thus there is no effect of a change in a on the ratio $\tilde{q}/\tilde{n}$. Differentiating Eq. (19) for the core with respect to a and recalling that $\tilde{q}/\tilde{n}$ is independent of a yields:

$$\frac{\partial\tilde{L}}{\partial a} = \tilde{n}\,\frac{\partial\tilde{n}}{\partial a}\left[\gamma\left(\frac{\tilde{q}}{\tilde{n}}\right)^2 + 1 - \gamma\right] \tag{21}$$

The term in squared brackets is unambiguously positive. Due to imperfect stabilization of employment after the shock, $\tilde{n}$ is negative. From Eq. (13′):

$$\frac{\partial\tilde{n}^{\mathrm{C}}}{\partial a} = \Lambda\,\frac{\partial\tilde{m}^{\mathrm{C}}}{\partial a} + \Delta(1-a)\,\frac{\partial\tilde{e}}{\partial a} - \Delta\tilde{e}$$

Appealing again to the envelope theorem and assuming that the effects due to changes in the optimal values of the policy instruments are sufficiently small, $\tilde{e}<0$ implies $\partial\tilde{n}^{\mathrm{C}}/\partial a>0$. A smaller size of the periphery implies that any given policy action by its central bank has a smaller impact on core variables. Consistent with the intuition, this allows the core's central bank to achieve a better stabilization of employment starting from the negative value caused by the shock and, in turn to suffer a smaller loss.

Under flexible exchange rates, a higher value of a worsens the tradeoff facing the core's central bank and has a decreasing impact on the ratio $\tilde{q}/\tilde{n}$. Starting from a negative value of the ratio, this implies that its absolute value increases. However, this does not necessarily cause a higher loss for the core's central bank. Differentiating Eq. (19) for the core with respect to a yields an expression identical to Eq. (20), which we repeat for convenience:

$$\frac{\partial\tilde{L}}{\partial a} = \tilde{n}\,\frac{\partial\tilde{n}}{\partial a}\left[\gamma\left(\frac{\tilde{q}}{\tilde{n}}\right)^2 + 1 - \gamma\right] + \gamma\tilde{n}\tilde{q}\,\frac{\partial(\tilde{q}/\tilde{n})}{\partial a} \tag{20′}$$

A positive CPI combined with negative employment ensures that the second term in this expression is positive (remember that $\tilde{q}/\tilde{n}$ is now a decreasing function of a). Hence, the higher is γ, the more likely it is that the core's central bank will suffer a higher loss. However, from Eq. (14′),

$$\frac{\partial\tilde{n}^{\mathrm{C}}}{\partial a} = [\Lambda - \eta\Delta(1-a)]\,\frac{\partial\tilde{m}^{\mathrm{C}}}{\partial a} + \eta\Delta(1-a)\,\frac{\partial\tilde{m}^{\mathrm{P}}}{\partial a} - \eta\Delta(\tilde{m}^{\mathrm{P}} - \tilde{m}^{\mathrm{C}})$$

Assuming that effects via changes in the optimal values of the policy instruments are small,

$$\frac{\partial\tilde{n}^{\mathrm{C}}}{\partial a} \cong -\eta\Delta(\tilde{m}^{\mathrm{P}} - \tilde{m}^{\mathrm{C}})$$

which is positive whenever a is greater than 0.5. Hence, a negative value of $\tilde{n}$ ensures that the first term in Eq. (20′) is negative. And this term is more significant the smaller is the weight γ attached by the core's central bank to inflation. Thus, if γ is sufficiently low, an increase in a will end up being beneficial for the core's central bank even if it increases the absolute value of the ratio $\tilde{q}/\tilde{n}$.[15] In a nutshell, the intuition is that, so long as γ is smaller than 1, a worse tradeoff can be beneficial by reducing the contractionary bias of non-cooperative monetary policy.

4.2. Large changes in relative size

The argument discussed above yields insights on what happens when we consider marginal changes in the relative size of core and periphery. In that case, it is safe to assume that changes in the equilibrium values of economic policy instruments are small. However, in reality, actual or prospective changes in the size of a currency area may well be significant. To investigate what happens in this case, we solve for the non-cooperative equilibrium of the game in the two exchange-rate regimes assigning numerical values to the structural parameters of the model and then computing the solution. This numerical example also allows us to verify whether the intuitions from the marginal-changes case can help explain the consequences of large variations in a. The numerical results are sensitive to the choice of parameter values. Nonetheless, as we shall see, they are consistent with those one would expect to obtain given the employment–inflation tradeoffs facing the central banks. The generality of the results on such tradeoffs thus lends some robustness to our example.

We consider three relative sizes of the two regions: $a=0.5$, $a=0.75$, and $a=1$. When $a=0.5$ the two regions are identical; for $a=0.75$ the periphery is one third the size of the core, and when $a=1$ the size of the periphery is negligible. (Symmetry of the model makes the cases in which a is smaller than 0.5 redundant.) The values we assign to the other structural parameters are: $\alpha=0.34$, $\delta=0.8$, $\varepsilon=0.8$, $\nu=0.4$, $\lambda=0.6$. Though arbitrary, these values can be defended based on the empirical evidence. $(1-\alpha)$, for instance, corresponds to the share of labor in a Cobb-Douglas production function, and a share of capital equal to $1/3$ is not unrealistic. We assume a relatively high value for δ to capture a potentially high sensitivity of trade flows to changes in real exchange rates. ε is the fraction of increases in output by which consumers in all regions increase their planned spending, a value of 0.8 does not seem far from reality. The value of ν is significantly lower because interest income can be thought of as less relevant in affecting consumption. It could be argued that the value of λ is relatively high for a short-run oriented model such as ours, although 0.5 would be the value suggested by a standard Baumol-Tobin model of money demand determination. Our parameter choice has the advantage of allowing a significant impact of the supply shock on employment and a non-negligible external effect of domestic

[15] In the numerical example discussed below this happens even with γ as high as 0.9.

policies on foreign employment under flexible exchange rates.[16] Numerical values of the reduced forms are shown in Appendix A (Table A1). Finally, we make the realistic assumption that central banks care much more about CPI inflation than about employment, choosing $\gamma = 0.9$. The solution of the system under the two regimes, together with the implied values of endogenous variables, loss functions, and inflation–employment ratios, is shown in Tables A2 and A3. Letting $\succ$ denote "preferred to," Table 1 summarizes the central banks' preference rankings over the size of the core region.

Both monetary authorities have preference rankings over the size of the currency area of the type: $1 \succ 0.75 \succ 0.5$. The larger core outcome is the first best for both policymakers. These results are consistent with the insights obtained analyzing marginal changes. The intuition is straightforward, although here one needs to be more careful in considering the impact of changes in a on the equilibrium values of the policy instruments. Consider first the periphery's central bank. As a increases, this central bank faces an improving tradeoff under both regimes. Under the asymmetric regime, the core's central bank always faces the same tradeoff, regardless of the value of a. However, as the periphery shrinks, the impact of imported inflation on the core economy becomes smaller. Other things being given, because central banks care more about inflation than about employment, facing a more favourable tradeoff as a increases strengthens the periphery's incentives to behave aggressively. Thus, for any given policy adopted by the core's central bank, the smaller impact on core inflation of inflation imported from the periphery as a increases (a *structure*-related effect), must be weighed against the fact that the periphery is induced to shift a larger amount of inflation upon the core (a *preference*-related effect), when determining the overall impact of the periphery's actions on the core economy. In principle, there may be situations in which inflation in the core rises as a increases as a consequence of the periphery's

Table 1
Summary of preference rankings in a two-region world

	Core's central bank
Asymmetric regime	$1 \succ 0.75 \succ 0.5$
Symmetric regime	$1 \succ 0.75 \succ 0.5$
	Periphery's central bank
Asymmetric regime	$1 \succ 0.75 \succ 0.5$
Symmetric regime	$1 \succ 0.75 \succ 0.5$

[16] As shown by Canzoneri and Henderson (1991), $\lambda = 0$ would imply no effect of monetary policy on foreign employment under flexible exchange rates and no impact of the supply shock on employment anywhere in the world.

behaviour.[17] This notwithstanding, one needs to remember that the final outcome of the stabilization game is not uniquely determined by the periphery's incentives and choices. In particular, the fact that, other things being given, facing a better tradeoff strengthens the incentives to act aggressively does not mean that the periphery *automatically* does so in the equilibrium of the game. For example, the periphery's aggressiveness is reduced as a goes from 0.75 to 1. Strategic interactions with other players can induce lower aggressiveness as equilibrium outcome when the periphery's policymaker optimally trades control of inflation for employment stabilization given the other player's reaction. In the case we are studying, the combined effect of these considerations is such that equilibrium inflation in the core decreases monotonically as a goes from 0.5 to 0.75 and 1. Under flexible exchange rates, the two central banks face identical tradeoffs when $a=0.5$, and none of them is able to export inflation to its partner. When the currency area becomes larger, the tradeoff facing its central bank worsens and equilibrium inflation increases. However, the smaller employment loss implied by a less aggressive monetary policy more than offsets the worse inflationary outcome, thus confirming the intuition from the marginal-changes case.[18]

The results in tables A2 and A3 allow us to address also the question of how the two regions' central banks rank the exchange-rate regimes we have considered. Consistent with the intuition, the periphery's central bank prefers the managed exchange rate regime when a is smaller than 1, whereas the central bank of the core would choose flexible exchange rates when $a=0.5$. Both central banks are indifferent about the exchange rate regime when $a=1$.[19] A relative size of the periphery as small as 0.25 is sufficient for the core's central bank to find the managed exchange rate regime preferable, even if it is characterized by a less favourable tradeoff. The inflation–employment ratio is higher under the asymmetric regime, but employment is considerably more stable and this effect more than offsets the inflation loss.

Our findings hint to two conclusions about the current developments of European monetary integration. If we think of the EMU as the core region in the model, our results suggest that its enlargement of EMU may be desirable and that, given the desirability of a large EMU, having chosen an EMS-2 regime to govern interactions between insiders (*ins*) and outsiders (*outs*) may actually prove optimal.

[17] Although this will not happen for values of a sufficiently close to 1, i.e. when the periphery has no impact on the core.

[18] Note that also under this regime the periphery is less aggressive as a increases from 0.75 to 1.

[19] That the core's central bank is indifferent between the two exchange-rate regimes when $a=1$ is intuitive. Indifference by the periphery's central bank follows from the fact that the core's authority chooses exactly the same policy irrespective of the regime when $a=1$. As a consequence, given an unchanging tradeoff across regimes and stable preferences, the periphery's central bank finds it optimal to select exactly the same point along its tradeoff under both regimes.

5. Third-region effects

We now turn our attention to a three-region model in which the currency area and its periphery interact with a rest-of-the-world region. Our analysis specifically addresses two different questions. The first one is whether the central banks' preference rankings over the size of the currency area or over the exchange-rate regime in the two-region world are affected by the presence of a third region. For example, can the presence of the United States influence preferences in Europe over the size of EMU? Second, we investigate the consequences of the enlargement of a currency area relative to its immediate periphery for the rest-of-the-world economy. The question we have in mind is whether enlargement of EMU will be harmful for the U.S. economy.

The world is now divided into three regions, the ''*core*,'' the ''*periphery*,'' and the ''*rest-of-the-world*'' (*Row*). The core and the periphery together constitute a region (*Cope*) that has the same size of the rest-of-the-world in the sense that, in the absence of disturbances, Cope and Row outputs are equal when measured in the same unit. Goods produced by the core and the periphery are imperfect substitutes for those produced by the rest-of-the-world. The supply side in the rest-of-the-world is the same as in the core and the periphery, i.e. it is still given by Eqs. (1) and (2). Consumer price indexes in each country, however, are now weighted averages of the prices of goods produced by the rest-of-the-world, the core, and the periphery. As shown in Fig. 2, Row consumers allocate a fraction b of their spending to goods produced in the Cope (a to the good produced by the core, and $(1-a)$ to that produced by the periphery). As before, the parameter a characterizes the size of the currency area. As a increases, the share of Row imports from Cope that comes from the core increases, while the import share from the periphery falls, thus describing a situation in which the size of the core relative to the periphery increases. When $a=1$ the core and Cope overlap, except for a small open economy that is left out, and Row and core are symmetric. The Row CPI is thus given by:

$$\begin{aligned} q^{R} &= (1-b)p^{R} + ab(p^{C} + e^{1}) + (1-a)b(p^{P} + e^{2}) \\ &= p^{R} + abz^{1} + (1-a)bz^{2} \end{aligned} \tag{22}$$

e^{1} and e^{2} are the Row currency prices of the core's and periphery's currencies, respectively, and z^{1} and z^{2} are the Row/core and Row/periphery real exchange rates:

$$\begin{aligned} z^{1} &= e^{1} + p^{C} - p^{R} \\ z^{2} &= e^{2} + p^{P} - p^{R} \end{aligned} \tag{23}$$

Cope consumers allocate a fraction b of their spending to the Row good, and

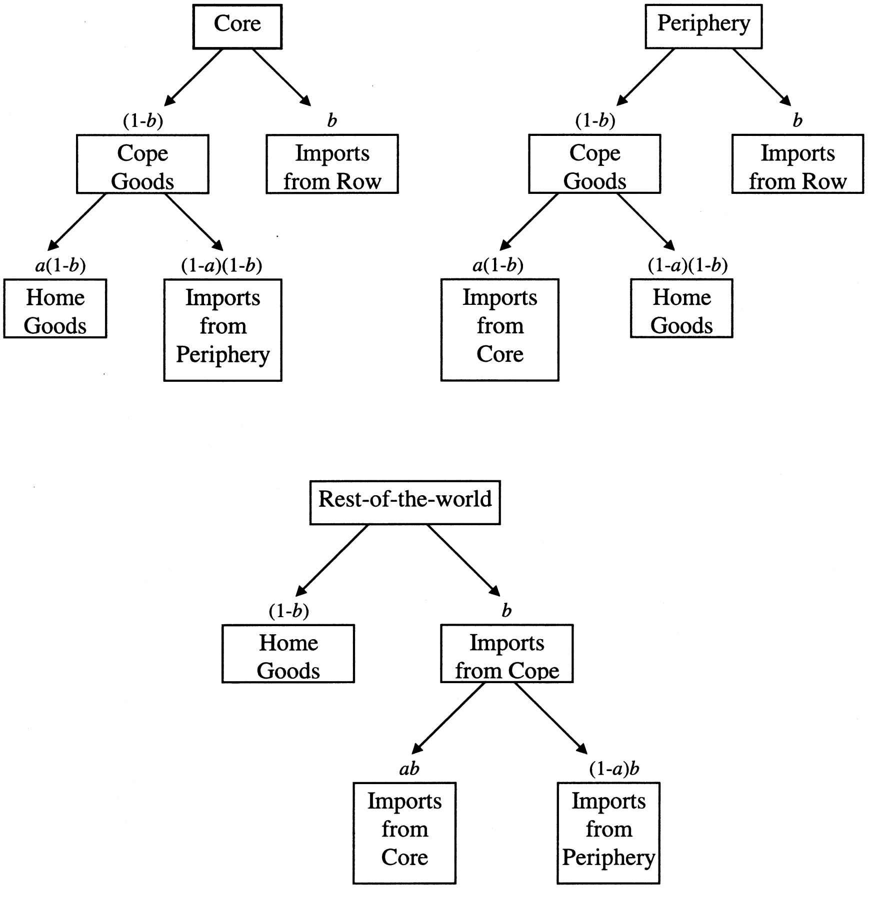

Fig. 2. The pattern of trade in a three-region world.

divide the rest of their spending between the two Cope goods, a to the core's good and $(1-a)$ to the periphery's, as they did before. The Cope CPIs are:[20]

$$\begin{aligned} q^{C} &= a(1-b)p^{C} + (1-a)(1-b)(p^{P} + e^{2} - e^{1}) + b(p^{R} - e^{1}) \\ &= p^{C} - bz^{1} - (1-a)(1-b)z^{3} \end{aligned}$$

[20] As in the two-region model, our assumptions on the trade pattern between Cope and Row and inside the Cope area are consistent with the implicit assumption that consumers have Cobb-Douglas preferences, which lead to constant shares of income being spent on the various goods according to the assumed pattern. However, we assume that preferences in the Cope and Row areas are asymmetric: consumers in both areas allocate a fraction b of their spending to goods produced in the other area. A consequence of the asymmetry in preferences between Cope and Row is that the prices of consumption baskets in the two regions are not equalized when expressed in a common currency.

$$q^{P} = (1-a)(1-b)p^{P} + a(1-b)(p^{C} + e^{1} - e^{2}) + b(p^{R} - e^{2})$$
$$= p^{P} - bz^{2} + a(1-b)z^{3} \tag{24}$$

where $z^3 = z^1 - z^2$ is the periphery/core real exchange rate.

The core's propensity to import from the periphery is $(1-a)$ times one minus the core's propensity to import from the Row. Thus, if the core's propensity to import from the Row is b, the core's propensity to import from the periphery is $(1-a)$ times $(1-b)$, and the total propensity to import of the core is $[b+(1-a)(1-b)]$. Equality between actual and planned expenditures on the three goods requires:

$$\begin{aligned} y^{R} &= \delta[az^{1} + (1-a)z^{2}] + \varepsilon[(1-b)y^{R} + aby^{C} + (1-a)by^{P}] \\ &\quad - \nu[(1-b)r^{R} + br] \\ y^{C} &= \delta[-z^{1} - (1-a)z^{3}] + \varepsilon[by^{R} + a(1-b)y^{C} + (1-a)(1-b)y^{P}] \\ &\quad - \nu[br^{R} + (1-b)r] \\ y^{P} &= \delta[-z^{2} + az^{3}] + \varepsilon[by^{R} + a(1-b)y^{C} + (1-a)(1-b)y^{P}] \\ &\quad - \nu[br^{R} + (1-b)r] \end{aligned} \tag{25}$$

These equations are the analogs to Eq. (5) for the two-region case. Ex ante real interest rates are defined as in the two-region model.[21] Real depreciation of a currency shifts world expenditure toward that region's good. As before, the effect of a real depreciation of the domestic currency depends on two factors: the common elasticity parameter δ and the size of the region with respect to whose currency the domestic currency is depreciating. Thus, for example, in the case $a=0.5$, if the core's currency depreciates against the Row's, the increase in expenditure on core's goods is twice as much as it would be were the core's currency depreciating against the periphery's reflecting the fact that the Row economy is twice the periphery and that, with perfect mobility of goods, ''depreciation against a larger market is more profitable.'' The larger a, the smaller the impact of a real depreciation against the periphery, for given impact of an analogous depreciation against the Row. If the periphery is a small economy, its impact on expenditure on core's goods is correspondingly small. This intuition is consistent with our assumptions about the pattern of trade: as a approaches 1, the periphery spends a larger share of its income on the core's goods, but its size is small. Also, the core spends a smaller share of its income on the periphery's

[21] Due to the asymmetry in consumers' preferences between the Cope and Row area, it is possible to show that Cope-Row real interest rate equalization does not hold, the real interest rate differential depending on movements in the real exchange rates.

goods. Thus, a real depreciation of the core against the periphery has a smaller impact on expenditure on core's goods as a increases.[22]

The uncovered interest parity conditions are:

$$i^{R} = i^{C} + E(e^{1}_{+1}) - e^{1}$$

$$i^{R} = i^{P} + E(e^{2}_{+1}) - e^{2} \tag{26}$$

The demand for real money balances is given by Eq. (8) in each region. The wage setting procedure is as in Section 2, and for the reasons outlined there we have the (rational) wage setting rule $w^{j}=0$, j=C, P, R. Hence, Eq. (11) still hold for all three regions.

As before, central banks in all regions seek to minimize quadratic loss functions which depend on the volatility of CPI-inflation and employment. We assume that the exchange-rate regime between Cope and Row is symmetric (floating exchange rates) and we consider two different monetary regimes within the Cope area: (*i*) an *asymmetric regime*, in which the periphery's central bank sets the value of $e^{3}=e^{1}-e^{2}$, the periphery/core nominal exchange rate; (*ii*) a *symmetric regime*, in which both the core's and the periphery's central banks set the money supply, and the intra-Cope exchange rate is floating. We maintain the assumption that central banks do not cooperate.

Under *managed exchange rates*, the reduced forms can be written as:

$$q^{C} = Am^{C} - \left(1 - \frac{A}{\eta}\right)(1-a)e^{3} - Bm^{R} + \Sigma x$$

$$q^{P} = Am^{C} + \left[a + \frac{A}{\eta}(1-a)\right]e^{3} - Bm^{R} + \Sigma x$$

$$q^{R} = Am^{R} - E(1-a)e^{3} - Bm^{C} + \Sigma x \tag{27}$$

$$n^{C} = \Lambda m^{C} + \Delta(1-a)e^{3} - \Theta m^{R} - Hx$$

$$n^{P} = \Lambda m^{C} + \left(\frac{\Lambda}{\eta} - \Delta a\right)e^{3} - \Theta m^{R} - Hx$$

$$n^{R} = \Lambda m^{R} - \Gamma(1-a)e^{3} - \Theta m^{C} - Hx \tag{28}$$

[22] An alternative explanation for a higher elasticity of spending on Cope goods to the Cope/Row real exchange rates than to the intra-Cope one could be based on the characteristics of the goods that are traded and on the presence of impediments to perfect mobility of goods across Cope and Row. In this sense, if the core depreciates against the Row currency, this may have a larger impact on expenditure on core's goods than a depreciation against the periphery's currency because, goods being imperfect substitutes, the characteristics of international trade may make it easier and more convenient for consumers in the core to shift from Row goods to core's than from periphery's goods to core's. In Ghironi and Giavazzi (1997) we briefly discuss how the elasticity of spending to changes in real exchange rates could be made dependent also on the size of Cope-Row trade as measured by b.

In the *symmetric floating rate regime* they are instead:

$$q^{C} = [Aa + \eta(1-a)]m^{C} - (\eta - A)(1-a)m^{P} - Bm^{R} + \Sigma x$$

$$q^{P} = [A(1-a) + \eta a]m^{P} - (\eta - A)am^{C} - Bm^{R} + \Sigma x \tag{27'}$$

$$q^{R} = Am^{R} - B[am^{C} + (1-a)m^{P}] + \Sigma x$$

$$n^{C} = [\Lambda - \eta\Delta(1-a)]m^{C} + \eta\Delta(1-a)m^{P} - \Theta m^{R} - Hx,$$

$$n^{P} = [\Lambda - \eta\Delta a]m^{P} + \eta\Delta am^{C} - \Theta m^{R} - Hx \tag{28'}$$

$$n^{R} = \Lambda m^{R} - \Theta[am^{C} + (1-a)m^{P}] - Hx$$

The notation that we have used in these equations must not confuse the reader: although the expressions of H and Σ as functions of the structural parameters are the same as in the two-region model, those of A, Δ, Λ, and η are different, due to the presence of the third region. We have used the above notation as it allows straightforward comparisons between reduced forms in the two- and the three-region models. Also, Eq. (27)– Eq. (28′) have been written taking already into account the results derived in Section 3 about the employment–inflation tradeoffs of core and periphery. In Appendix B, we show that these results are not affected by the presence of a third region in the model. Note that the Row always faces the same employment–inflation tradeoff irrespective of the relative size of core and periphery and of the nature of the intra-Cope monetary arrangement. This is consistent with the intuition we have given in Section 3 about the determinants of the tradeoff: changes in the relative size of core and periphery and in the exchange-rate regime between them do not affect the structural characteristics of the Row economy, which determine the tradeoff facing its central bank. This tradeoff coincides with the tradeoff facing the core under the symmetric intra-Cope regime when $a=1$—i.e. when the currency area becomes equal in size to Row by encompassing the whole Cope region except for a residual economy – and always facing the core when the asymmetric arrangement is implemented in the Cope area—i.e. when the currency area's central bank sets the money supply for the whole area. These findings are a consequence of our assumptions about the Cope-Row exchange-rate regime and of the symmetry between Cope and Row in the absence of disturbances.

Our results about the tradeoffs facing each region, as the size of the currency area changes from $a=0.5$ to $a=1$, are illustrated graphically in Figs. 3 and 4. These figures are drawn assuming that a positive realization of the supply shock (x) has caused inflation and unemployment. Irrespective of a and of the intra-Cope

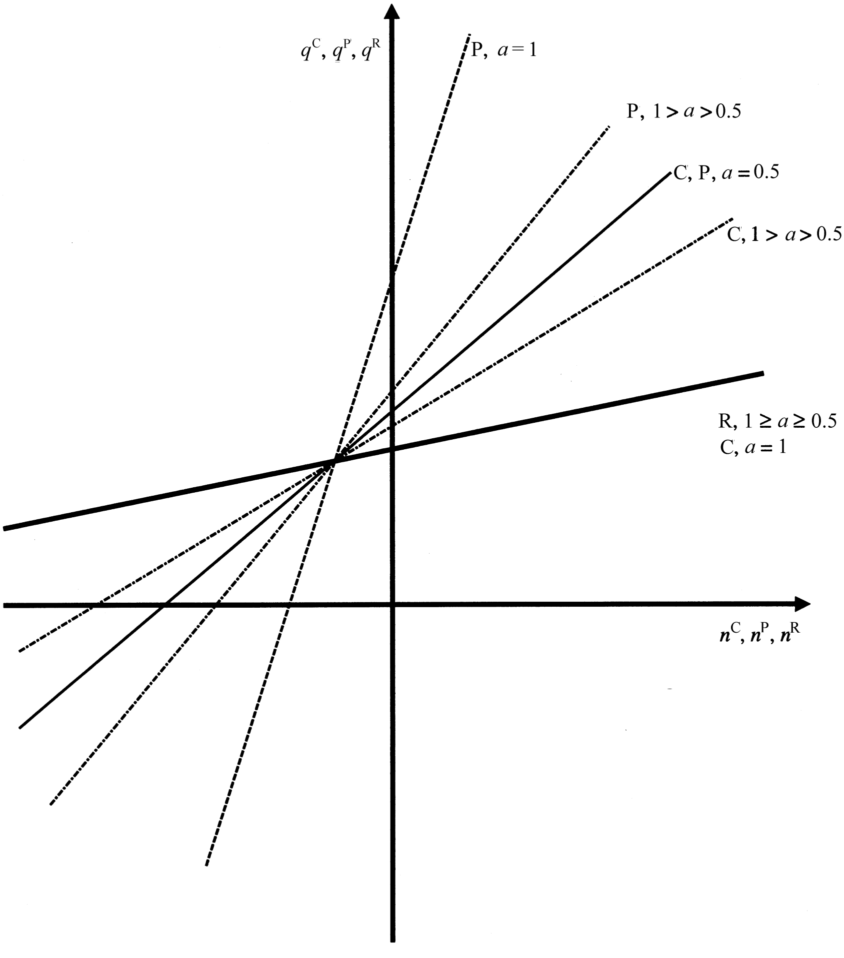

Fig. 3. Employment–inflation tradeoffs, symmetric intra-Cope regime.

exchange-rate regime, the Row always faces the flattest, and thus most unfavourable, tradeoff, given by the thick solid line. Under the symmetric regime in the Cope area (Fig. 3), both the core and the periphery face the same tradeoff when $a=0.5$, given by the thin solid line steeper than the Row tradeoff. As a increases, the tradeoff faced by the periphery becomes steeper, rotating towards the most favourable situation, which is achieved when $a=1$. Instead, the core's tradeoff becomes flatter, rotating towards the Row tradeoff, achieved when $a=1$. Under the asymmetric regime (Fig. 4), the core always faces the same tradeoff as the Row, irrespective of the size of the currency area, whereas the periphery faces the same tradeoff it would face under the symmetric regime as a varies between 0.5 and 1, and its tradeoff is always better than the core's.

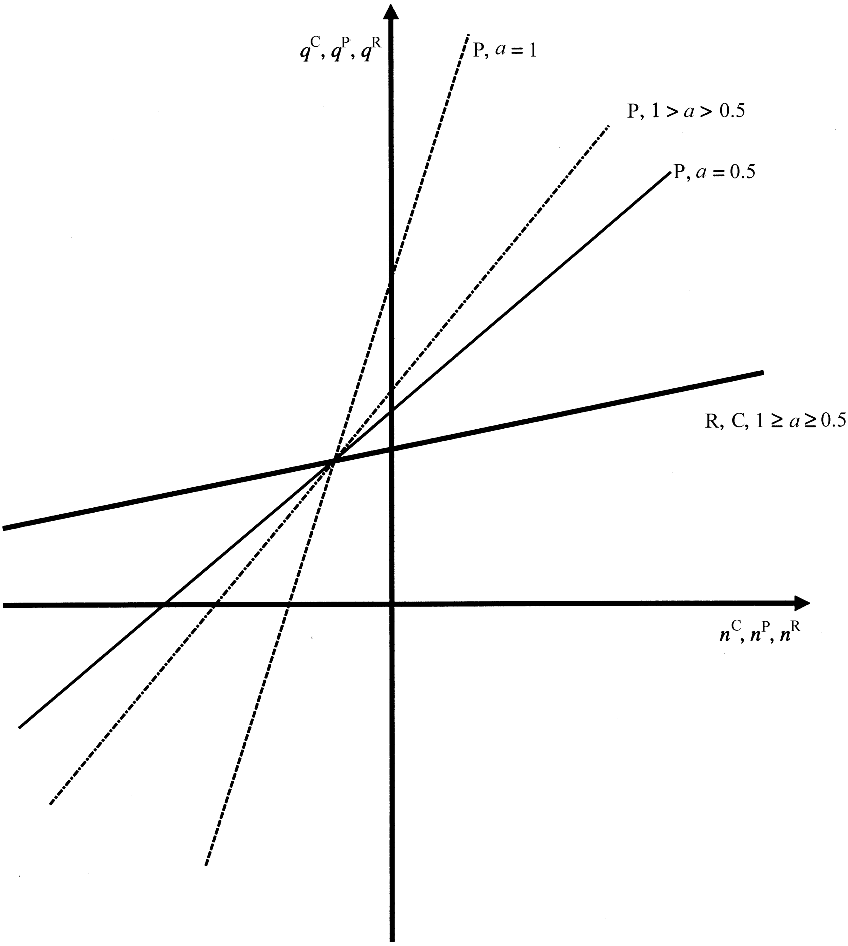

Fig. 4. Employment–inflation tradeoffs, asymmetric intra-Cope regime.

6. Monetary interactions in a three-region world

6.1. Small changes in relative size

As in the two-region model, we begin by investigating the impact of marginal changes in a on the equilibrium of the stabilization game, making use of our results on the behavior of the employment–inflation tradeoffs facing the policymakers.

Solving the central banks' minimization problem under the assumption of no cooperation among them leads to first-order conditions analogous to those in Section 4, with the instrument controlled by the periphery's central bank depending on the intra-Cope monetary arrangement. These first-order conditions can be written as in Eq. (17), so that Eq. (18) holds for all central banks. Let us focus initially on the periphery.

The central bank's loss function can be written as in Eq. (19) and differentiating with respect to a yields again Eq. (20). As in Section 4, the second term of this expression is unambiguously negative. To determine the sign of $\partial\tilde{L}/\partial a$, we need to determine the behavior of $\partial\tilde{n}^{\mathrm{P}}/\partial a$. From Eq. (28), we have that, under managed exchange rates:

$$\frac{\partial\tilde{n}^{\mathrm{P}}}{\partial a}=\Lambda\frac{\partial\tilde{m}^{\mathrm{C}}}{\partial a}+\left(\frac{\Lambda}{\eta}-\Delta a\right)\frac{\partial\tilde{e}^{3}}{\partial a}-\Delta\tilde{e}^{3}-\Theta\frac{\partial\tilde{m}^{\mathrm{R}}}{\partial a}\cong-\Delta\tilde{e}^{3}$$

for a sufficiently small change in a. When all exchange rates are flexible, Eq. (28′) yield:

$$\begin{aligned}\frac{\partial\tilde{n}^{\mathrm{P}}}{\partial a}&=(\Lambda-\eta\Delta a)\frac{\partial\tilde{m}^{\mathrm{C}}}{\partial a}+\eta\Delta a\frac{\partial\tilde{m}^{\mathrm{P}}}{\partial a}-\eta\Delta(\tilde{m}^{\mathrm{P}}-\tilde{m}^{\mathrm{C}})-\Theta\frac{\partial\tilde{m}^{\mathrm{R}}}{\partial a}\\&\cong-\eta\Delta(\tilde{m}^{\mathrm{P}}-\tilde{m}^{\mathrm{C}})\end{aligned}$$

Optimal policy reactions to a shock that causes inflation and unemployment by policymakers that are sufficiently inflation-averse ensure that both these expressions are positive. Starting from a negative value of employment, a marginal increase in a allows the periphery's central bank to achieve a better stabilization of employment. From Eq. (20), this allows us to conclude that, under both exchange-rate regimes, the central bank's loss unambiguously declines as a consequence of a higher value of a.

Eq. (18) ensures that changes in a have no effect on the equilibrium value of the inflation–employment ratio in the core economy under managed exchange rates. Hence, differentiating Eq. (19) for the core with respect to a yields Eq. (21) again. From Eq. (28), it follows that:

$$\frac{\partial\tilde{n}^{\mathrm{C}}}{\partial a}=\Lambda\frac{\partial\tilde{m}^{\mathrm{C}}}{\partial a}+\Delta(1-a)\frac{\partial\tilde{e}^{3}}{\partial a}-\Delta\tilde{e}^{3}-\Theta\frac{\partial\tilde{m}^{\mathrm{R}}}{\partial a}\cong-\Delta\tilde{e}^{3}>0$$

Thus, a marginal increase in a allows the core's central bank to achieve a better stabilization of employment after a supply shock and is therefore unambiguously beneficial.

Under flexible exchange rates, differentiation of Eq. (19) with respect to a gives Eq. (20′). As in Section 4, the second term of the expression is unambiguously positive. The first term depends on the impact of changes in a on the equilibrium value of employment. From Eq. (28′),

$$\frac{\partial \tilde{n}^{C}}{\partial a} = [\Lambda - \eta\Delta(1-a)]\frac{\partial \tilde{m}^{C}}{\partial a} + \eta\Delta(1-a)\frac{\partial \tilde{m}^{P}}{\partial a} - \eta\Delta(\tilde{m}^{P} - \tilde{m}^{C}) - \Theta\frac{\partial \tilde{m}^{R}}{\partial a} \cong -\eta\Delta(\tilde{m}^{P} - \tilde{m}^{C}) \geq 0$$

Thus, the first term of Eq. (20′) is negative. As in the two-region world, so long as $\gamma < 1$, a worsening of the employment–inflation tradeoff facing the central bank can end up being beneficial by inducing better employment stabilization.

The tradeoff facing the Row's central bank is not affected by changes in the intra-Cope exchange-rate regime. Hence, differentiation of Eq. (19) for the Row with respect to a yields Eq. (21). Thus, to determine the impact of marginal changes in a on the Row's central bank's loss, we need to determine the effect of the change on equilibrium employment. Eqs. (28) and (28′) yield:

$$\frac{\partial \tilde{n}^{R}}{\partial a} = \Lambda\frac{\partial \tilde{m}^{R}}{\partial a} - \Gamma(1-a)\frac{\partial \tilde{e}^{3}}{\partial a} + \Gamma\tilde{e}^{3} - \Theta\frac{\partial \tilde{m}^{C}}{\partial a} \cong \Gamma\tilde{e}^{3} < 0$$

and

$$\frac{\partial \tilde{n}^{R}}{\partial a} = \Lambda\frac{\partial \tilde{m}^{R}}{\partial a} - \Theta\left[a\frac{\partial \tilde{m}^{C}}{\partial a} + (1-a)\frac{\partial \tilde{m}^{P}}{\partial a}\right] + \Theta(\tilde{m}^{P} - \tilde{m}^{C}) \cong \Theta(\tilde{m}^{P} - \tilde{m}^{C}) \leq 0$$

respectively. Thus, a small increase in the size of the core relative to the periphery is expected to cause worse stabilization of employment in the Row and a higher loss for the central bank.

This result hinges on the fact that monetary externalities on employment have opposite sign between Cope and Row relative to intra-Cope effects.[23] For example, a monetary contraction in the periphery causes core employment to decrease, but it raises employment in the Row. The intuition is as follows. Consider the Row economy. Row employment is given by $n^{R} = m^{R} + \lambda i^{R}$. Uncovered interest parity allows to write: $i^{R} = i^{P} - e^{2}$. A monetary contraction in the periphery raises the periphery's nominal interest rate and causes the Row currency to depreciate against the periphery's, i.e. e^{2} increases. Our assumptions on the pattern of trade ensure that the impact on the periphery's interest rate is larger than that on the exchange rate, so that i^{R} and employment in the Row increase. Instead, core employment can be written as $n^{C} = m^{C} + \lambda(i^{P} + e^{3})$. Under flexible exchange rates, a contraction in the periphery causes e^{3} to decrease. As before, our hypotheses

[23]See Eqs. (28) and (28′).

ensure that a significant decrease in e^3 more than offsets the expansionary impact of a higher i^P. The same effect obtains when e^3 is the instrument controlled by the periphery's central bank.

To summarize, if a increases marginally, the periphery's central bank is expected to be better off under both exchange-rate regimes, whereas the Row's is expected to be worse off. The core's central bank should be better off under managed exchange rates in the Cope area, and it could be better off under flexible exchange rates provided that the weight attached to inflation in the loss function is sufficiently smaller than 1.

6.2. Large changes in relative size

As in Section 4, we now compare the insights from the formal analysis of small changes in a to the results obtained when the solution of the stabilization game among the three central banks is investigated through a numerical example that allows for significant changes in the relative size of core and periphery.[24] The values we assign to the structural parameters of the model are the same as in Section 4; we assume that $b=0.1$, to capture the idea that trade in goods between the Cope and the Row region is limited. As far as the relative size of the two Cope regions, we consider again the three alternative values for a: 0.5, 0.75, and 1. The reduced forms that we use in this exercise are shown in Appendix A (Table A4). The solution of the system of first-order conditions under the two alternative regimes, together with the implied values of endogenous variables and loss functions, is summarized in Tables A5 and A6. Table 2 summarizes the central banks' rankings of preferences over the optimal size of the currency area.

Table 2
Summary of preference rankings in a three-region world

	Core's central bank
Asymmetric regime	$1>0.75>0.5$
Symmetric regime	$1>0.75>0.5$
	Periphery's central bank
Asymmetric regime	$1>0.75>0.5$
Symmetric regime	$1>0.75>0.5$
	Row central bank
Asymmetric regime	$1>0.75>0.5$
Symmetric regime	$1>0.75>0.5$

[24] As in the two-region case, an analytical solution of the game is hardly interpretable.

Under both regimes, the periphery unambiguously benefits from facing a more favourable tradeoff as a increases. Differently from what happened in the two-region world, and from the prediction of the small-changes case, unemployment in the periphery increases as the size of the core gets larger under managed exchange rates. Facing a more favourable tradeoff gives the periphery's central bank incentives to behave aggressively. Significant adjustments in equilibrium policies cause unemployment to increase. However, the gain from more stable inflation more than offsets the employment loss.

The core's central bank is better off as a increases under both regimes. Under managed exchange rates, the inflation–employment ratio is constant. Better stabilization of employment due to the smaller impact of any given action by the periphery benefits the central bank. Under flexible exchange rates, the inflation–employment ratio increases with a in absolute value, but the gain from employment stabilization more than offsets the inflation loss, notwithstanding the high value of γ. Thus, adding a third region to the model does not alter the preference rankings of the core and periphery's central banks' over the optimal size of the currency area.

Interestingly, the central bank of the rest-of-the-world region is left better off by increases in the relative size of the core, in contrast with the predictions of the analysis of small changes in a. The intuition is as follows. As a increases, the impact abroad of any given action by the periphery becomes smaller, while the impact of any action by the core on the Row economy becomes larger. The periphery has an incentive to behave more aggressively, but the core's policy becomes less aggressive if its size is larger. Under managed exchange rates this happens because the core, dealing with a smaller immediate neighbour, has lower incentives to try to dump the consequences of the periphery's aggressiveness on the Row. Under flexible exchange rates this effect is to be combined with the effect on the core's policy of facing a worsening tradeoff as a increases. Under both regimes, the Row central bank reacts optimally by reducing its monetary contraction. The inflation–employment ratio remains unchanged as a varies, but employment stabilization turns out to be more successful and this allows the Row central bank to suffer a smaller loss.

One more observation is in order about Row-Cope interactions. Under managed exchange rates both the core and the Row face the same employment–inflation tradeoff, independently of the size of the currency area. Consequently, the presence of a non-negligible periphery—and, as shown in Ghironi and Giavazzi (1997), the absence of intra-Cope monetary cooperation—is crucial to obtain movements in the Row/core exchange rate. If the size of the periphery were negligible, or if it were non-negligible but intra-Cope externalities were internalized, equal tradeoffs would lead to equal equilibrium policies in the Row and in the currency area, and there would be no changes in the Row/core exchange rate. This observation shows that facing a more favourable tradeoff is not *necessary* in order to successfully run beggar-thy-neighbour policies: the Row central bank faces the same tradeoff as the core's but still manages to appreciate against the core, thus exporting some inflation to the currency area. The absence of intra-Cope cooperation and the presence of a non negligible periphery which successfully exports inflation to both the core and the Row shift the balance between the Row and the core's central bank in a direction that is favourable to the Row authority.

Thus, once large changes in a are considered results from the three-region model appear to reinforce the conclusion that a relatively large EMU would be preferable to a small one for *all* monetary authorities. They also have implications for the impact of EMU on the international monetary system. It has been argued that the likelihood of transatlantic monetary cooperation will be low, at least in the first years of EMU, when the European Central Bank (ECB) is primarily interested in establishing its anti-inflationary reputation. Given this observation, fears have been expressed that a larger EMU might have harmful consequences for the U.S. economy by confronting the United States with a bigger monetary bloc. Our analysis shows that these fears may prove wrong. A larger EMU may, on the contrary, dampen the consequences of non-cooperative policymaking in Europe and between Europe and the U.S. and be beneficial on both sides of the Atlantic. Also, our results suggest that a larger EMU may dampen the extent of policy-induced fluctuations in the dollar–euro exchange rate because it will face the ECB and the Federal Reserve with incentives that are increasingly similar.

When we consider central banks' preferences over the intra-Cope exchange-rate regime for given size of the core, we see that, consistent with the intuition, the periphery prefers managed rates when a is smaller than 1. Interestingly, adding the third region alters the core's central bank ranking of the two regimes when $a=0.75$: flexible exchange rates are now preferred to the asymmetric regime. The gain from lower inflation more than offsets the larger employment loss in this case. The Row central bank suffers a smaller loss if the regime between core and periphery is asymmetric. This is intuitive. The inflation–employment ratio is the same under both regimes regardless of a. However, stabilization of employment is better under managed exchange rates. In this case, the core's central bank always faces the same tradeoff as the Row's and is therefore less aggressive than under flexible rates. This allows the Row's central bank to adopt less contractionary policies that are less harmful to employment.[25] Hence, our results suggest not only that a larger EMU may prove beneficial to the U.S., but also that the choice of an asymmetric regime between the *ins* and the *outs* may turn out to be optimal from the perspective of U.S. monetary authorities. However, a larger EMU may be

[25] As in the two-region world, central banks are indifferent to the exchange-rate regime if $a=1$.

necessary relative to what suggested by the two-region model to make the EMS-2 regime preferable from the ECB's perspective.

7. Conclusions

The purpose of this paper was to fill a gap in the literature on policymaking in interdependent economies by analyzing how the relative size of regions affects their monetary interactions under alternative exchange-rate regimes.

Our main finding has been that the tradeoff a central bank faces depends on the size of the economy for which it sets monetary policy—which does not necessarily coincide with the size of its own region, as in the case of the core central bank in an asymmetric exchange-rate regime. We have shown that, for inflation-averse central banks, the employment–inflation tradeoff improves the smaller the relevant economy. This result is independent of the exchange-rate regime if this does not alter the size of the relevant economy. In particular, the tradeoff facing the region whose central bank controls the exchange rate in an asymmetric regime does not change moving to a symmetric flexible exchange rate regime. This result corrects previous contributions to the literature.

We have used our theoretical framework to explore the issue of the optimal size of a currency area from different central banks' perspectives, both in a two-region world, in which only the currency area and a peripheral region exist, and in a three-region world, in which the currency area and the periphery interact with the rest of the world. We have explored the consequences both of marginal changes in the size of the currency area, which do not entail significant changes in the equilibrium values of the policy instruments, and of large changes in size, which cause correspondingly large adjustments in monetary policies. We have found that introducing a third region does not alter the area's central bank's preferences over the optimal size of the currency area. A larger area is preferable under both exchange rate regimes. Interestingly, when large changes in size are considered, under plausible assumptions about parameter values, the central bank of the rest-of-the-world region is made better off by increases in the size of the currency area. We have also discussed the central banks' rankings of preferences over alternative exchange-rate regimes. In particular, we have argued that the rest-of-the-world's central bank is likely to be better off when the regime between the currency area and its immediate periphery is asymmetric.

Although we have studied the issue from the limited perspective of policymakers' optimal reactions to a symmetric supply disturbance, we believe that our results shed new light on the optimal currency area literature, which so far has mainly focused on the structural characteristics of the regions that join to adopt the same currency, neglecting how the size of the currency area affects its interactions with the rest of the world. Our results have implications for EMU and its consequences for the international monetary system.

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Appendix A

Numerical solutions to the stabilization games

Table A1. Reduced forms in a two-region world

(1) *Asymmetric regime*

$$q^{C} = 0.2425m^{C} - 0.7585(1-a)e + 0.9272x$$

$$q^{P} = 0.2425m^{C} + (0.2415 + 0.7585a)e + 0.9272x$$

$$n^{C} = 0.7133m^{C} + 0.3145(1-a)e - 0.2140x$$

$$n^{P} = 0.7133m^{C} + (0.7101 - 0.3145a)e - 0.2140x$$

(2) *Symmetric regime*

$$q^{C} = (1.0044 - 0.7619a)m^{C} - 0.7619(1-a)m^{P} + 0.9272x$$

$$q^{P} = (0.2425 + 0.7619a)m^{P} - 0.7619am^{C} + 0.9272x$$

$$n^{C} = (0.3974 + 0.3159a)m^{C} + 0.3159(1-a)m^{P} - 0.2140x$$

$$n^{P} = (0.7133 - 0.3159a)m^{P} + 0.3159am^{C} - 0.2140x$$

Table A2.[a]

Non-cooperative asymmetric regime	Periphery's size negligible ($a=1$)	Periphery's size small ($a=0.75$)	Periphery's size equal to core's ($a=0.5$)
Core's money ($\tilde{m}^{C}$)	−1.8026	−1.9464	−2.0669
Nominal periphery/core ($\tilde{e}$)	−0.4169	−0.4173	−0.3834
Real periphery/core ($\tilde{z}$)	−0.3608	−0.3612	−0.3318
Core's CPI ($\tilde{q}^{C}$)	0.4901	0.5343	0.5714
Periphery's CPI ($\tilde{q}^{P}$)	0.0732	0.1170	0.1880
Core's employment ($\tilde{n}^{C}$)	−1.4997	−1.6351	−1.7485
Periphery's employment ($\tilde{n}^{P}$)	−1.6646	−1.8002	−1.9002
Loss core's CB	0.2205	0.2622	0.2998
Loss periphery's CB	0.1410	0.1682	0.1964
$\tilde{q}^{C}/\tilde{n}^{C}$	−0.3268	−0.3268	−0.3268
$\tilde{q}^{P}/\tilde{n}^{P}$	−0.0439	−0.0650	−0.0990

[a] In this table and in the following ones, the values of the policy instruments and of the endogenous variables should be multiplied by x, while the values of the loss functions should be multiplied by x^2. A positive realization of x is a negative supply-side shock, which lowers employment and raises the CPI. Given that variables are in logs, the numbers we report in the tables are the elasticities of policy instruments and endogenous variables with respect to the supply shock implied by the relevant policymaking regime and size of the currency area. We then calculate the losses implied by those elasticities.

Table A3.

Non-cooperative symmetric regime	Periphery's size neglibible ($a=1$)	Periphery's size small ($a=0.75$)	Periphery's size equal to core's ($a=0.5$)
Core's money (m^{C})	−1.8026	−2.5860	−2.8939
Periphery's money (m^{P})	−2.2177	−2.7828	−2.8939
Real periphery/core (z)	−0.3608	−0.1710	0
Core's CPI (q^{C})	0.4901	0.3376	0.2254
Periphery's CPI (q^{P})	0.0732	0.1399	0.2254
Core's employment (n^{C})	−1.4997	−2.0741	−2.2781
Periphery's employment (n^{P})	−1.6646	−2.1522	−2.2781
Loss core's CB	0.2205	0.2664	0.2823
Loss periphery's CB	0.1410	0.2404	0.2823
q^{C}/n^{C}	−0.3268	−0.1627	−0.0990
q^{P}/n^{P}	−0.0439	−0.0650	−0.0990

Table A4. Reduced forms in a three-region world

(1) *Asymmetric intra-Cope regime*

$$q^{C} = 0.2640m^{C} - 0.0215m^{R} - 0.4908(1 - a)e^{3} + 0.9272x$$

$$q^{P} = 0.2640m^{C} - 0.0215m^{R} + (0.5092 + 0.4908a)e^{3} + 0.9272x$$

$$q^{R} = 0.2640m^{R} - 0.0215m^{C} - 0.0414(1 - a)e^{3} + 0.9272x$$

$$n^{C} = 0.7470m^{C} - 0.0337m^{R} + 0.1120(1 - a)e^{3} - 0.2140x$$

$$n^{P} = 0.7470m^{C} - 0.0337m^{R} + (1.4409 - 0.1120a)e^{3} - 0.2140x$$

$$n^{R} = 0.7470m^{R} - 0.0337m^{C} - 0.0651(1 - a)e^{3} - 0.2140x$$

(2) *Symmetric intra-Cope regime*

$$q^{R} = 0.2640m^{R} - 0.0215[am^{C} + (1 - a)m^{P}] + 0.9272x$$

$$n^{R} = 0.7470m^{R} - 0.0337[am^{C} + (1 - a)m^{P}] - 0.2140x$$

$$q^{C} = (0.5184 - 0.2544a)m^{C} - 0.2544(1 - a)m^{P} - 0.0215m^{R} + 0.9272x$$

$$q^{P} = (0.2640 + 0.2544a)m^{P} - 0.2544am^{C} - 0.0215m^{R} + 0.9272x$$

$$n^{C} = (0.6889 + 0.0581a)m^{C} + 0.0581(1 - a)m^{P} - 0.0337m^{R} - 0.2140x$$

$$n^{P} = (0.7470 - 0.0581a)m^{P} + 0.0581am^{C} - 0.0337m^{R} - 0.2140x$$

Table A5

Non-cooperative intra-Cope asymmetric regime	Periphery's size negligible ($a=1$)	Periphery's size small ($a=0.75$)	Periphery's size equal to core's ($a=0.5$)
Core's money ($\tilde{m}^{C}$)	−1.8423	−1.8843	−1.9060
Row's money ($\tilde{m}^{R}$)	−1.8423	−1.8506	−1.8550
Nominal periphery/core ($\tilde{e}^{3}$)	−0.2130	−0.1815	−0.1376
Real periphery/core ($\tilde{z}^{3}$)	−0.1168	−0.0995	−0.0754
Real Row/core ($\tilde{z}^{1}$)	0	−0.0127	−0.0193
Real Row/periphery ($\tilde{z}^{2}$)	0.1168	0.0868	0.0561
Core's CPI ($\tilde{q}^{C}$)	0.4805	0.4918	0.4977
Periphery's CPI ($\tilde{q}^{P}$)	0.2674	0.3102	0.3601
Row CPI ($\tilde{q}^{R}$)	0.4805	0.4810	0.4813
Core's employment ($\tilde{n}^{C}$)	−1.5281	−1.5642	−1.5829
Periphery's employment ($\tilde{n}^{P}$)	−1.8111	−1.8055	−1.7658

Row employment ($\tilde{n}^{R}$)	−1.5281	−1.5299	−1.5308
Loss core's CB	0.2206	0.2312	0.2367
Loss periphery's CB	0.1962	0.2063	0.2142
Loss Row CB	0.2206	0.2212	0.2214
$\tilde{q}^{C}/\tilde{n}^{C}$	−0.3144	−0.3144	−0.3144
$\tilde{q}^{P}/\tilde{n}^{P}$	−0.1476	−0.1718	−0.2039
$\tilde{q}^{R}/\tilde{n}^{R}$	−0.3144	−0.3144	−0.3144

Table A6

Non-cooperative Intra-Cope Symmetric regime	Periphery's size negligible ($a=1$)	Periphery's size small ($a=0.75$)	Periphery's size equal to core's ($a=0.5$)
Core's money ($\tilde{m}^{C}$)	−1.8423	−2.0955	−2.2497
Periphery's money ($\tilde{m}^{P}$)	−2.2532	−2.3023	−2.2497
Row's money ($\tilde{m}^{R}$)	−1.8423	−1.8619	−1.8685
Real periphery/core ($\tilde{z}^{3}$)	−0.1168	−0.0588	0
Real Row/core ($\tilde{z}^{1}$)	0	−0.0138	0.3810
Real Row/periphery ($\tilde{z}^{2}$)	0.1168	0.0726	0.3810
Core's CPI ($\tilde{q}^{C}$)	0.4805	0.4272	0.3735
Periphery's CPI ($\tilde{q}^{P}$)	0.2674	0.3200	0.3735
Row CPI ($\tilde{q}^{R}$)	0.4805	0.4818	0.4823
Core's employment ($\tilde{n}^{C}$)	−1.5281	−1.7195	−1.8315
Periphery's employment ($\tilde{n}^{P}$)	−1.8111	−1.8620	−1.8315
Row employment ($\tilde{n}^{R}$)	−1.5281	−1.5324	−1.5339
Loss core's CB	0.2206	0.2230	0.2305
Loss periphery's CB	0.1962	0.2194	0.2305
Loss Row CB	0.2206	0.2219	0.2223
$\tilde{q}^{C}/\tilde{n}^{C}$	−0.3144	−0.2484	−0.2039
$\tilde{q}^{P}/\tilde{n}^{P}$	−0.1476	−0.1718	−0.2039
$\tilde{q}^{R}/\tilde{n}^{R}$	−0.3144	−0.3144	−0.3144

Appendix B

Proof that results on tradeoffs hold in the three-region model

The proof that the tradeoff for the regions that controls the exchange rate in the asymmetric intra-Cope regime improves its size becomes smaller runs exactly as in Section 3.[26] The proof that $\partial n^{P}/\partial m^{P}$ is a decreasing function of a under flexible exchange rates is unchanged too, except for e being replaced by e^{3}.

Showing that $\partial q^{P}/\partial m^{P}$ is instead an increasing function of a is easy also in a three-region world. From Eq. (24), the periphery's CPI can be rewritten as

[26] The uncovered interest parity condition that is used to make the argument is now $i^{c}-e^{3}=i^{P}$.

$$q^{\mathrm{P}} = p^{\mathrm{P}} + [ab - (a+b)]z^2 + a(1-b)z^1$$

Therefore:

$$\frac{\partial q^{\mathrm{P}}}{\partial m^{\mathrm{P}}} = \frac{\partial p^{\mathrm{P}}}{\partial m^{\mathrm{P}}} + [ab - (a+b)]\frac{\partial z^2}{\partial m^{\mathrm{P}}} + a(1-b)\frac{\partial z^1}{\partial m^{\mathrm{P}}}$$

$$\frac{\partial q^{\mathrm{P}}}{\partial e^3} = \frac{\partial p^{\mathrm{P}}}{\partial e^3} + [ab - (a+b)]\frac{\partial z^2}{\partial e^3} + a(1-b)\frac{\partial z^1}{\partial e^3}$$

Multiplying both sides of the second equation by $\partial e^3/\partial m^{\mathrm{P}}$, we have:

$$\frac{\partial q^{\mathrm{P}}}{\partial e^3}\frac{\partial e^3}{\partial m^{\mathrm{P}}} = \frac{\partial p^{\mathrm{P}}}{\partial m^{\mathrm{P}}} + [ab - (a+b)]\frac{\partial z^2}{\partial m^{\mathrm{P}}} + a(1-b)\frac{\partial z^1}{\partial m^{\mathrm{P}}} = \frac{\partial q^{\mathrm{P}}}{\partial m^{\mathrm{P}}}$$

But, $\partial e^3/\partial m^{\mathrm{P}} = \eta$, so that $\partial q^{\mathrm{P}}/\partial e^3 = (1/\eta)(\partial q^{\mathrm{P}}/\partial m^{\mathrm{P}})$. From this point on, the proof runs as in Section 3 and the results can be used to show that the tradeoff facing the periphery does not change across intra-Cope exchange-rate regimes, irrespective of the value of a.

The arguments about the core's tradeoff are as in Section 3, while the behavior of the Row's tradeoff has been explained in Section 5.

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