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Exchange Rate Regimes, Location, and Specialization

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This paper investigates the effects of fixed versus flexible exchange rates on firms' location choices and on countries' specialization patterns. In a two-country, two-differentiated-goods monetary model, uncertainty arises after wages are set and prices are optimally chosen. The paper shows that countries are more specialized under flexible than fixed rates, which indicates that the pattern of specialization is not uniquely defined by trade models but also depends on the exchange rate regime. The creation of a currency area endogenously increases the desirability of such an area by reducing the asymmetry of shocks across member countries. The results also shed light on the effects of exchange rate variability on trade. [JEL F1, F31, F33, F4, L16, R12]

In the presence of price rigidities, countries tend to be more specialized under flexible exchange rates than under fixed exchange rates, thus suggesting that the pattern of specialization indicated by any trade model is not unique but also depends

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on the exchange rate regime. An important implication follows: the net benefits that can be expected from the creation of a currency area are endogenous to—and rise with—the creation of the currency area, as the latter induces sectoral dispersion and consequently reduces the degree of asymmetry of shocks across candidate countries. A second implication is that an increase in exchange rate variability would have an ambiguous effect on trade by increasing interindustry trade and reducing intra-industry trade. The implications highlight some possible real effects arising from the creation of the European Monetary Union (EMU).

Both the main results and the implications of this paper adequately capture some facts highlighted in the literature. The positive effect of flexible exchange rates on trade specialization is consistent with Fontagné and Freudenberg (1999), who find that exchange rate variability increases interindustry trade and reduces intra-industry trade (thus raising specialization) among European Union (EU) countries. The predicted positive impact of fixed exchange rates on the symmetry of shock is consistent with the results of Fatás (1997), who shows that the business cycle correlation of EU countries increased after the introduction of the European Monetary System. The endogeneity of the desirability of a currency union is consistent with Frankel and Rose (1998), who find that industrial countries that trade more with each other have more correlated business cycles; hence, if the EMU enhances trade among its member countries, shocks should become more symmetric.[1] The ambiguous effect of exchange rate variability on trade is highlighted in the empirical results of Clark and others (2004).

To illustrate, consider a world composed of two countries (1 and 2) engaging in both intra- and interindustry trade of two differentiated goods (*A* and *B*). Assume country 1 is a net exporter of good *A*. After prices are chosen, consider a shift of demand from good *B* to good *A*. Under fixed exchange rates, the shock equally affects all firms producing the same good, regardless of their location. Under floating, however, currency 1 appreciates, and the consequent substitution effect reduces the initial increase of demand experienced by firms producing *A* in country 1 and generates a further increase in the demand for varieties of *A* produced in country 2 (the opposite holds true for industry *B*.)

This implies that, on average, endogenous exchange rate movements provide a partial adjustment to shocks for firms located in the country that is a net exporter of the good they produce but generate further disturbance for firms producing the same good in the net importer country. As a consequence, under a flexible exchange rate regime, firms located in the country relatively specialized in (net exporter of) the good they produce experience a lower variability in sales than their competitors.

To the extent that firms dislike variability in sales, under flexible exchange rates the uneven sectoral adjustment to shocks gives firms an incentive to locate in the country that is relatively specialized in the good they produce. Under fixed exchange rates, however, all firms face the same variability in sales regardless of their location, so this incentive does not arise. Thus, countries should be more

[1]See, however, Imbs (1999), who finds that neither the degree of trade intensity nor a fixed exchange rate regime seems to matter for the synchronization of the business cycle.

specialized under flexible exchange rates than under fixed rates. This would suggest that nominal rigidities and shocks could induce an additional incentive for specialization, in addition to those suggested by trade and location theory.

The novelty of our results stems from the integration of basic elements of open macroeconomic, trade, and location theory (i.e., price rigidities, specialization patterns, and location choices), thus overcoming some limitations of each approach. Open macroeconomics usually neglects countries' specialization patterns.[2] Trade theory usually ignores the existence of short-run market rigidities and assigns no role to the nominal exchange rate. Location theory normally does not consider the effects of exchange rate regimes on the location choices of firms.[3] While several papers have analyzed the effects of exchange rate regimes on foreign direct investment (FDI), this literature (except for Aizenman, 1992) usually neglects the endogenous nature of the exchange rate and fails to capture the heterogeneity of sectors of production in the economy.[4] Hence, it does not allow us to infer how changes in FDI induced by exchange rate variability influence the pattern of specialization.

We develop a two-country, two-differentiated-good, one-factor monetary model in which countries engage in both inter- and intraindustry trade. Price rigidities, decreasing returns to scale, and international labor immobility allow us to tailor the model toward the representation of the short-run adjustment to shocks. The effectiveness of the exchange rate stems from the fact that countries do not have an identical production structure and that wages are set and prices are optimally chosen before the resolution of uncertainty. We ignore the existence of trade costs to neutralize the backward and forward linkages, and thus focus on the location incentives and specialization patterns induced by the sectoral impact of exchange rate adjustments.[5]

I. The Model

The model extends Blanchard and Kiyotaki (1987) to a two-country two-differentiated-good setup.[6] This is similar to a one-period version of the new open economy approach (see Obstfeld and Rogoff, 2000), but with two tradable goods.

[2]See, however, Faruqee (1996), which introduces nominal rigidities in a two-country model of imperfect competition and investigates the implications of different trade patterns for real exchange rate dynamics. Tille (2006) builds on Ricci (1997a) and Faruqee (1996) to investigate how the differential impact of exchange rate movements across sectors leads to substantial welfare differences across households in a given country.

[3]See, however, Ricci (1998) for agglomeration effects arising from exchange rate variability. For a review of the location literature, see Fujita, Krugman, and Venables (1999). For a survey of location theory in a historical perspective, see Fujita and Thisse (1996).

[4]Most of the investigations are based on a partial equilibrium analysis of the behavior of a single firm and find that when the variability of the exchange rate exogenously increases, a risk-averse firm will raise FDI (see Cushman, 1988; Goldberg and Kolstad, 1994; and Campa and Goldberg, 1995) or increase foreign production and decrease foreign sales (see Broll, Wahl, and Zilcha, 1995). In a two-country model, Aizenman (1992) finds that under fixed exchange rates, both domestic investment and foreign direct investment are higher than under flexible exchange rates.

[5]For a description of how these linkages shape economic geography, see Krugman (1991).

[6]We leave out some of the features of the Blanchard and Kiyotaki (1987) model. For our purposes, it is unnecessary to replicate their endogenous wage setting, to employ differentiated labor supply, or to introduce work in the utility function.

Consider a world composed of two countries (1 and 2) that are inhabited by an equal number of agents (L) and produce two types of goods (A and B). Each good is produced in n differentiated varieties (indexed by $i = 1, \ldots, n$ for good A and by $j = 1, \ldots, n$ for good B) worldwide, each variety being manufactured by a different firm. The only factor of production—labor—is homogenous, immobile across countries, and mobile across industries (this last assumption is not essential).

The two countries have a mirror-image production structure: a share η of the n firms in industry A are located in country 1, and an identical share η of the n firms in industry B are located in country 2. Without loss of generality, we assume $\frac{1}{2} < \eta < 1$, so that country 1 (country 2) is relatively specialized in good A (good B). A sector is defined as the part of an industry located in one country; hence, there are four sectors: $A1$, $A2$, $B1$, and $B2$. The parameter η may be thought of as capturing trade-theoretical reasons for a given specialization pattern.[7]

Uncertainty, Timing of Actions, Price Setting, and Monetary Rule

The formal analysis focuses on uncertainty arising from demand shocks. Monetary, productivity, and exchange rate shocks are discussed in the second subsection of Section II.

Before the resolution of uncertainty, workers of each country set the domestic wage (w_k, with $k = 1,2$) and commit to supply as much labor as demanded by firms at this wage level. Firms observe the wage and choose optimal prices as markup over expected marginal costs. Because the wage and the associated employment in the absence of shocks are not relevant to our analysis (what matters are the fluctuations around the initial equilibrium), we assume that in the absence of shocks the wage chosen would ensure full employment (i.e., every worker would supply one unit of labor).[8]

After the resolution of uncertainty, a new equilibrium in the goods and money markets is reached: taking wages and prices as given, consumers choose optimal consumption and money balances, and firms choose optimal employment levels. Monetary authorities do not pursue discretionary policies. When shocks occur in a flexible exchange rate regime, monetary authorities abstain from intervention and let the exchange rate adjust the money market and the trade balance. When shocks occur in a fixed exchange rate regime, authorities are committed to eliminate any pressure on the exchange rate by adjusting money supply in order to equilibrate the money market (trade may be unbalanced).[9]

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[7]This mirror-image location of firms could be derived endogenously by introducing a comparative advantage or factor specificity. A previous draft of this paper allowed for a Ricardian comparative advantage in a new trade theory setup, as in Ricci (1997c, 1999), but the resulting mathematical complication obscured the intuition and required simulations to present qualitatively identical results.

[8]Menu costs or costs in the price-setting decision process may be the reason wages and prices are not adjusted once shocks are known. Nominal rigidities are quite common in recent international macroeconomics (see Obstfeld and Rogoff, 2000).

[9]It is irrelevant to our results whether the fixed exchange rate regime is managed symmetrically or asymmetrically. We solve the model for the symmetric case.

Consumer Maximization Problem

All individuals share the same utility function. A representative consumer of country k chooses nominal money balances (m_k) and consumption of varieties of goods A and B (c_{iAk} and c_{jBk}, respectively) so as to maximize the following random preferences:

$$U_k = \left(C_{Ak}^{\gamma} C_{Bk}^{1-\gamma}\right)^{\lambda} \left(m_k / P_k\right)^{1-\lambda}, \quad 0<\gamma<1,\ 0<\lambda<1,\ k=1,2, \tag{1}$$

with

$$C_{Ak} = \left(\sum_{i=1}^{n} c_{iAk}^{(\sigma-1)/\sigma}\right)^{\sigma/(\sigma-1)}, \quad C_{Bk} = \left(\sum_{j=1}^{n} c_{jBk}^{(\sigma-1)/\sigma}\right)^{\sigma/(\sigma-1)}, \quad \sigma>1,$$

where P_k is the true price index of consumption in country k, σ is the elasticity of substitution among varieties of the same good, and γ is the random share of expenditure on good A, whose mean value is 0.5 and whose percentage change ($\mu = d\gamma/\gamma$) is bounded in $(-\Omega, \Omega)$ with mean 0 and variance u^2.

The nominal wealth of a representative individual of country k (q_k) is the sum of income (y_k) and endowment of domestic currency (m_k^s). Each individual supplies labor to domestic firms at the given wage and receives profits from these firms; individual income is, therefore, a share $1/L$ of domestic firms' revenues. Individual endowment of money is a fraction $1/L$ of the domestic stock of money, which may vary under fixed exchange rates because of monetary intervention. The consumer's budget constraint is:

$$\sum_{i=1}^{n} p_{iA}^{k} c_{iAk} + \sum_{j=1}^{n} p_{jB}^{k} c_{jBk} + m_k^d = q_k \equiv m_k^s + y_k, \tag{2}$$

where p_{iA}^k and p_{jB}^k are the prices of variety i of good A and of variety j of good B, measured in the currency of the consumer's country k.

Aggregate demands of country k for money (M_k^d) and for each variety of good A produced in country f (A_{fk}, $f=1,2$) are given by (the expressions for good B can be derived analogously):

$$A_{11} = \frac{p_{A1}^{-\sigma}}{P_{A1}^{1-\sigma}} \gamma\lambda Q_1, \quad A_{21} = \frac{\left(e\, p_{A2}\right)^{-\sigma}}{P_{A1}^{1-\sigma}} \gamma\lambda Q_1, \quad \boldsymbol{M}_1^d = (1-\lambda) Q_1, \tag{3}$$

$$A_{12} = \frac{\left(p_{A1}/e\right)^{-\sigma}}{P_{A2}^{1-\sigma}} \gamma\lambda Q_2, \quad A_{22} = \frac{p_{A2}^{-\sigma}}{P_{A2}^{1-\sigma}} \gamma\lambda Q_2, \quad \boldsymbol{M}_2^d = (1-\lambda) Q_2, \text{ with}$$

$$P_{A1} = P_{A1} = \left(n_{A1}\, p_{A1}^{1-\sigma} + n_{A2} \left(e p_{A2}\right)^{1-\sigma}\right)^{1/(1-\sigma)},$$

$$P_{A2} = \left(n_{A1} \left(p_{A1}/e\right)^{1-\sigma} + n_{A2} p_{A2}^{1-\sigma}\right)^{1/(1-\sigma)} = P_{A1}/e,$$

$$Q_k = n_{Ak}\, p_{Ak}\, x_{Ak} + n_{Bk}\, p_{Bk}\, x_{Bk} + M_k^s = L\, q_k, \quad k=1,2,$$

where Q_k is the aggregate wealth of country k, P_{Ak} is true price index of good A in country k, e is the exchange rate defined as units of the currency of country 1 for one unit of the currency of country 2 (and is equal to 1 under a fixed exchange rate regime), and n_{ck} is the number of varieties of good c ($c = A, B$) produced in country k.

Firms' Maximization Problem

The market structure is the usual large group monopolistic competition based on Dixit and Stiglitz (1977) and often adopted in trade theory thereafter (see Helpman and Krugman, 1985). There is no free entry; endogenizing the number of firms would not alter the results.

Production functions are identical for all firms and exhibit diminishing returns to labor. The output (x_{ck}) of a typical firm producing a variety of good c ($c = A,B$) in location k ($k = 1,2$) is given by $x_{ck} = l_{ck}^{\alpha}$, where l_{ck} is the employment of such a firm. We assume for simplicity that $\alpha = 0.5$; this assumption is not essential as long as $0<\alpha<1$.

Before the resolution of uncertainty, a typical firm of sector ck takes the wage and other firms' behavior as given and chooses its price (p_{ck} in its domestic currency) to maximize expected profits (π_{ck})[10]:

$$E[\pi_{ck}] = E\left[p_{ck}\, x_{ck}^{d} - w_k\, l_{ck}\right] = E\left[p_{ck}\, x_{ck}^{d} - w_k \left(x_{ck}^{d}\right)^{1/\alpha}\right], \quad c = A,B;\ k = 1,2, \tag{4}$$

where E is the expectation operator and x_{ck}^{d} is the demand for one variety of good c produced in k:

$$x_{Ak}^{d} = A_{k1} + A_{k2}, \quad x_{Bk}^{d} = B_{k1} + B_{k2}.$$

The profit-maximizing price (p_{ck}) for good c produced by a typical firm of country k is therefore set as a markup over expected marginal cost:

$$P_{ck} = \frac{\sigma}{\sigma - 1} E\left[\frac{w_k}{\alpha}\left(x_{ck}^{d}\right)^{(1-\alpha)/\alpha}\right] = \frac{\sigma}{\sigma - 1} E\left[\frac{w_k}{\alpha}\left(l_{ck}\right)^{1-\alpha}\right], \quad c = A,B;\ k = 1,2, \tag{5}$$

where σ approximates, for n large enough, the perceived elasticity of demand.

After the resolution of uncertainty, firms choose optimal employment. As prices and wages are now given, the profit function is rising in output (around the initial equilibrium) and firms will find it optimal to satisfy demand, thus bringing the goods market into equilibrium ($x_{ck}^{d} = x_{ck}$).[11] The profit function is also concave

[10]Producer currency pricing is the prevailing assumption in recent open economy literature. Alternatively, some authors have focused on the pricing-to-market assumption (for example, Faruqee, 1995; and Betts and Devereux, 2000). See Obstfeld and Rogoff (2000) for a summary of the arguments against the pricing-to-market assumption.

[11]Firms would not find it optimal to satisfy very large increases in demand, since marginal cost would rise above price. We rule out this possibility by assuming that the shocks are opportunely bounded, so that the qualitative outcome of a comparative statics exercise would correspond to the outcome of a simulation exploiting the full nonlinearities of the model.

in output, implying that firms dislike variability in sales. On any given variety, the law of one price applies.

Equilibrium in the Absence of Shocks

In the absence of shocks, the only difference between the two countries is given by their symmetric pattern of specialization (η). Wages are set at the same level (w) in both countries. Because all firms face an identical wage and a marginal cost function, which is linear in output, they all choose the same price, which can be normalized to 1 ($p_{ck} = p = 1$, with $c = A,B$; $k = 1,2$). Prices being equal, an identical share of expenditure will be allocated to each variety. All firms have identical employment, output, and profits. Both countries have the same aggregate income and wealth, and every consumer demands all varieties in the same amount. After normalizing the exchange rate and the price of each variety to 1, we obtain the following (where M^{WR} is the equilibrium world real stock of money):

$$p = e = 1, \quad x = l^{1/2} = \left(\frac{L}{n}\right)^{1/2} = \frac{\lambda}{1-\lambda}\frac{M^{WR}}{2n}, w = \frac{\sigma-1}{\sigma}\frac{1}{2x}, \quad p = \frac{\sigma+1}{2\sigma}x. \tag{6}$$

II. Uncertainty and Equilibrium Location

In this section, we investigate the equilibrium distribution of firms that occurs if firms are allowed to choose location before any other action takes place. To this purpose, for each exchange rate regime, we first study how shocks affect firms' sales and expected profits in each sector for a given location structure (η). We then compare firms' expected profits within the same industry across locations and discuss the equilibrium location structure. The exercise is based on comparative statics calculations.

Equilibrium Location Pattern

To discuss the effect of demand shocks under a fixed exchange rate regime, we assume a given location distribution (η). Given the assumptions outlined in Section I, before the occurrence of shocks, the economy is described by the set of relations discussed in the last subsection of Section I. Under fixed exchange rates, any demand shock (μ) gives rise only to a direct demand effect deriving from the change in preferences. While the money market is equilibrated by the intervention of monetary authorities, the new goods market equilibrium is:

$$X_{Ak} = \mu, \quad X_{Bk} = -\mu, \tag{7}$$

where $X_{ck} = dx_{ck}/x_{ck}$. Considering the distribution of shocks, ex ante all firms face the same variability of output and the same expected profits independently of their location:

$$E[\pi_{ck}] = x - wE[x(1+X_{ck})]^2 = \pi - w\,x^2\,u^2, \tag{8}$$

with x and π defined in the final subsection of Section I. Hence, firms are indifferent to location. We can thus state the following:

Proposition 1. Under a fixed exchange rate regime, any distribution of firms is an equilibrium location pattern.

More generally, if η were to be endogenously determined, say, via factors such as comparative advantage or location theory, a fixed exchange rate regime would not induce a deviation from such an equilibrium allocation of resources.

Under flexible rates, the exchange rate would react to balance trade. Following any demand shock, the direct demand effect is accompanied by the substitution effect owing to the exchange rate adjustment, which affects firms differently according to their industry and location. For example, an increase in demand for good *A* would tend to improve the trade balance of country 1 (which is specialized in *A*) and to deteriorate the balance of country 2, thus prompting an appreciation of the currency of country 1. This would, in turn, generate a substitution effect away from all goods produced by country 1 and in favor of those produced by country 2. Such a substitution effect would dampen the initial shock for firms producing *A* in country 1 (or *B* in country 2), but it would exacerbate the shock for firms producing *B* in country 1 (or *A* in country 2). More generally, the possibility of shocks would induce firms to anticipate a lower variability in sales in the location where they would be part of the net exporting sector. Since firms dislike variability in sales, they would prefer such a location. Formally, the goods and money market equilibria require

$$de/e = -2(2\eta - 1)z\mu, \quad X_{ck} = g_{ckD}\mu, \tag{9}$$

with

$$z = 1/(1 + 4\eta(1-\eta)(\sigma - 1)), \quad 0 < g_{A1D} = -g_{B2D} = 2(1-\eta)\sigma z < 1,$$
$$g_{A2D} = -g_{B1D} = 2\eta\sigma z > 1,$$

where the change in the exchange rate ensures trade balance, which reflects changes in sales in the four different sectors. By confronting the coefficients g_{ckD}, we can derive that firms located in the country relatively specialized in their industry (i.e., firms producing varieties of *A* in country 1 or of *B* in country 2) face a lower variability in sales and higher expected profits than firms of the same industry located in the other country (i.e., producing *A* in country 2 or *B* in country 1):

$$E[\pi_{ck}] = x - wE[x(1 + X_{ck})]^2 = \pi - wx^2 g_{ckD}^2 u^2,$$
$$E[\pi_{A1}] - E[\pi_{A2}] = E[\pi_{B2}] - E[\pi_{B1}] = wx^2 4(2\eta - 1)\sigma^2 z^2 u^2 > 0. \tag{10}$$

The difference in expected profits across locations for the same industry increases with the degree of specialization (η) and with the variance of the shocks

(u^2). Because firms enjoy higher expected profits if they are located in the country relatively specialized in the good they produce, countries are fully specialized in equilibrium. We can thus state the following:

Proposition 2. Under a flexible exchange rate regime, firms have an incentive to locate in the country that is relatively specialized in the good they produce. In the absence of any other location incentive (such as comparative advantage), the equilibrium location pattern is given by full specialization.

The extreme specialization under flexible rates is obviously due to the exogenous nature of the initial distribution of firms (η).[12] More generally, when other trade or location incentives for specialization are present, the equilibrium location pattern would be derived by weighing, for the marginal firm: (1) the incentive to locate in the country that is relatively specialized in the good the firm produces, in order to benefit from the adjustment role of the exchange rate; and (2) the efficiency loss associated with the departure from the location choice dictated by the comparative advantage or other location incentives. As a result, countries would be more specialized under flexible than under fixed exchange rates.

Other Sources of Uncertainty

In this section we argue that similar location incentives arise from monetary, exchange rate, and productivity shocks.[13]

Monetary and exchange rate shocks

Under a fixed exchange rate regime, any change in money stock is reflected in an equal change in expenditure on both goods, independently of the country in which the shock originated. All firms experience the same change in sales; hence, the same variability in sales and the same expected profits. Any distribution of firms is an equilibrium.

Under a flexible exchange rate regime, the exchange rate movements associated with monetary and exchange rate shocks induce expenditure shifts across countries. Each firm located in the country that has the largest market share of the good that the firm produces will bear a smaller share of the expenditure shift than its foreign competitors. Such a firm would therefore face a lower variability in sales and higher expected profits. To the extent that countries are net exporters of the good of which they have the largest market share, under flexible rates, firms would have an incentive to locate in the country relatively specialized in the

[12]The results would apply also in the presence of endogenous monetary policy, as long as such a policy would not find it optimal to fully counteract shocks.

[13]For a formal analysis of these shocks, see the Working Paper version of this paper (Ricci, 1997a). In all cases but one (exchange rate shocks), the exchange rate is an endogenous variable.

good they produce, and the only equilibrium location pattern would be full specialization.[14]

Supply shocks

Supply shocks are very similar to demand shocks, once we allow for an automatic response of monetary policy. In the presence of price rigidities, it is reasonable to assume that monetary authorities adjust domestic money supply in the same direction as the change in average domestic productivity, to accommodate changes in expenditure and reduce employment fluctuations. For simplicity, consider the case in which money is adjusted at the same rate as productivity.

Under a fixed exchange rate regime, the monetary accommodation allows expenditure on all goods to change by the world average productivity growth. All firms face the same variability in sales, and any location pattern is an equilibrium.

Under a flexible exchange rate regime, the country whose average productivity rises relative to that of the other country experiences a depreciation of its currency. The consequent substitution effect eases the adjustment of firms located in the country relatively specialized in the good they produce and constitutes an element of further disturbance for the other firms. Firms located in the country relatively specialized in their industry experience a lower variability in sales and higher expected profits. The equilibrium location of firms is full specialization.

Also for monetary, exchange rate, and productivity shocks, the presence of comparative advantage or other location incentives would imply that specialization under flexible rates would not be full but would be higher than under fixed rates.

III. Conclusions

This paper shows that fixed and flexible exchange rate regimes are associated with different location incentives when demand, supply, monetary, and exchange rate shocks arise in the presence of short-run price rigidities. Countries tend be more specialized under flexible exchange rates than under fixed exchange rates. In fact, when real shocks occur, flexible exchange rates provide a partial adjustment to the firms located in the country whose aggregate shocks to net exports are positively correlated with the firm's shocks and generate further disturbance to the other firms. This effect does not occur under fixed rates. A similar intuition would apply to the cases of monetary and exchange rate shocks.

Our findings imply that the pattern of specialization suggested by any trade model is not unique but depends on the exchange rate regime. If one considers that firms' location choices are normally influenced by factors such as comparative advantage, economic geography, and so on, our model would suggest that under fixed exchange rates the equilibrium location distribution would be dictated by only those factors. Under flexible exchange rates, however, additional location incentives would arise: the equilibrium location pattern would need to be

[14]In a setup with nonsymmetric countries, there would also be agglomeration effects (see Ricci, 1998).

derived by weighing, for the marginal firm, the incentive to locate in the country that is relatively specialized in the good the firm produces and the efficiency loss associated with the departure from the location dictated by trade and geography factors.

This paper provides a theoretical argument for the endogeneity of the optimum currency area (OCA) criterion; that is, the net benefits that can be expected from a currency area increase with the creation of the currency area, because this reduces international specialization and the asymmetry of shocks across candidate countries.[15] This would suggest that the creation of the European Monetary Union could induce a relocation of economic activity that would make countries more similar and shocks more symmetric.

This paper also offers two explanations for the puzzle related to the effects of exchange rate variability on trade. Whereas most theoretical analyses (based on partial equilibrium models) suggest a negative effect, most empirical studies found no effect or a small negative one (see, for example, Gagnon, 1993; Dell'Ariccia, 1999; and Clark and others, 2004). First, a partial equilibrium analysis may overstate the negative effect of the exchange rate variability, as it fails to recognize that such variability is partly an endogenous response to shocks. Second, under flexible rates, economic uncertainty (whether in fundamentals or in the exchange rate itself) unevenly affects firms in different industries, suggesting that a small impact at the aggregate level may hide large differences at the industrial level.

The model has been kept simple to avoid unnecessary mathematical complication and to highlight the intuition; however, we believe that our results would hold qualitatively under more general assumptions or in a more complicated setup. For example, one could extend the setup to a multiperiod framework (as long as in every period some shocks arise after prices are optimally chosen); introduce financial assets (as long as contingent claims markets are incomplete); consider that firms maximize expected utility from profits (as long as international equity markets are imperfect);[16] relax price rigidities (as long as firms dislike variability in sales, the result would hold for demand and monetary shocks);[17] allow for foreign direct investment (the location incentives we described would apply to both the main firm and its foreign subsidiaries); endogenously derive the number of firms in each industry (by allowing for free entry and introducing a fixed production cost); consider firms' relocation choices (the overall effect would depend on the extent of relocation costs versus the difference in expected operating profits

[15]See Bayoumi (1994) and Ricci (1997b) for models of the net benefits of a currency area. For surveys of the OCA literature, see de Grauwe (1992), Masson and Taylor (1992), and Tavlas (1994). Frankel and Rose (1998) argued the endogeneity of the OCA criterion on the basis of an empirical analysis, and refer to the mechanism described in this paper (or Ricci, 1997a) for the support of a formal model.

[16]In this case, however, prices would be set differently across sectors (as expected utility from profits is not linear in sales), and the model would need to be solved via simulations.

[17]Firms may dislike variability in sales for additional reasons such as the cost of firing workers, bankruptcy costs, and the cost of maintaining stocks of goods in order to smooth periods of excess demand. Moreover, firms would behave in a risk-averse manner if the owners are risk-averse and face incomplete financial markets or if managers are risk-averse and face an imperfect labor market or get nonmarketable payoffs (such as satisfaction or reputation).

across locations); or allow for probabilistic creation and destruction of firms, to analyze the effect of changes in regimes. All these interesting extensions are possibilities for future studies.

REFERENCES

Aizenman, Joshua, 1992, "Exchange Rate Flexibility, Volatility, and Domestic and Foreign Direct Investment," *IMF Staff Papers,* Vol. 39, No. 4, pp. 890–922.

Bayoumi, Tamim, 1994, "A Formal Model of Optimum Currency Areas," *IMF Staff Papers,* Vol. 41, No. 4, pp. 537–54.

Betts, Caroline, and Michael Devereux, 2000, "Exchange Rate Dynamics in a Model of Pricing-to-Market," *Journal of International Economics,* Vol. 50 (February), pp. 215–44.

Blanchard, Olivier, and Nobuhiro Kiyotaki, 1987, "Monopolistic Competition and the Effects of Aggregate Demand," *American Economic Review,* Vol. 77 (September), pp. 647–66.

Broll, Udo, Jack Wahl, and Itzhak Zilcha, 1995, "Indirect Hedging of Exchange Rate Risk," *Journal of International Money and Finance,* Vol. 14 (October), pp. 667–78.

Campa, Josè, and Linda Goldberg, 1995, "Investment in Manufacturing, Exchange Rates and External Exposure," *Journal of International Economics,* Vol. 38 (May), pp. 297–320.

Clark, Peter, Azim Sadikov, Natalia Tamirisa, Shang-Jin Wei, and Li Zeng, 2004, *A New Look at Exchange Rate Volatility and Trade Flows,* IMF Occasional Paper No. 235 (Washington: International Monetary Fund).

Cushman, David, 1988, "Exchange Rate Uncertainty and Foreign Direct Investment in the United States," *Weltwirtschaftliches Archiv,* Vol. 124 (2), pp. 322–36.

de Grauwe, Paul, 1992, *The Economics of Monetary Integration* (New York: Oxford University Press).

Dell'Ariccia, Giovanni, 1999, "Exchange Rate Fluctuations and Trade Flows: Evidence from the European Union," *IMF Staff Papers,* Vol. 46 (September), pp. 315–34.

Dixit, Avinash, and Joseph Stiglitz, 1977, "Monopolistic Competition and Optimum Product Diversity," *American Economic Review,* Vol. 67 (June), pp. 297–308.

Faruqee, Hamid, 1995, "Pricing to Market and the Real Exchange Rate," *IMF Staff Papers,* Vol. 42, No. 4, pp. 855–81.

———, 1996, "Real Exchange Rate and the Pattern of Trade," *Journal of International Money and Finance,* Vol. 15, No. 2, pp. 313–36.

Fatás, Antonio, 1997, "EMU: Countries or Regions? Lessons from the EMS Experience," *European Economic Review,* Vol. 41 (April), pp. 743–51.

Fontagné, Lionel, and Michael Freudenberg, 1999, "Endogenous Symmetry of Shocks in a Monetary Union," *Open Economies Review,* Vol. 10, pp. 263–87.

Frankel, Jeffrey, and Andrew Rose, 1998, "The Endogeneity of the Optimum Currency Area Criteria," *The Economic Journal,* Vol. 108 (July), pp. 1009–25.

Fujita, Masahisa, Paul Krugman, and Anthony Venables, 1999, *The Spatial Economy: Cities, Regions, and International Trade* (Cambridge, Massachusetts: MIT Press).

Fujita, Masahisa, and Jacques-François Thisse, 1996, "Economics of Agglomeration," *Journal of the Japanese and International Economies,* Vol. 10 (December), pp. 339–78.

Gagnon, Joseph, 1993, "Exchange Rate Variability and the Level of International Trade," *Journal of International Economics,* Vol. 34 (May), pp. 269–87.

Goldberg, Linda, and Charles Kolstad, 1994, "Foreign Direct Investment, Exchange Rate Variability and Demand Uncertainty," *International Economic Review,* Vol. 36 (4), pp. 855–73.

Helpman, Elhanan, and Paul Krugman, 1985, *Market Structure and Foreign Trade* (Cambridge, Massachusetts: MIT Press).

Imbs, Jean, 1999, "Fluctuations, Bilateral Trade and the Exchange Rate Regime," Cahiers de Recherches Économiques du DEEP No. 9906 (Lausanne, Switzerland: Département d'économétrie et d'économie politique, Université de Lausanne).

Krugman, Paul, 1991, *Geography and Trade* (Cambridge, Massachusetts: MIT Press).

Masson, Paul R., and M. P. Taylor, 1992, "Common Currency Areas and Currency Unions: An Analysis of the Issues," CEPR Discussion Paper No. 617 (London: Center for Economic Policy Research).

Obstfeld, Maurice, and Kenneth Rogoff, 2000, "New Directions for Stochastic Open Economy Models," *Journal of International Economics,* Vol. 50 (February), pp. 117–53.

Ricci, Luca Antonio, 1997a, "Exchange Rate Regimes and Location," IMF Working Paper 97/69 (Washington: International Monetary Fund).

———, 1997b, "A Model of an Optimum Currency Area," IMF Working Paper 97/76 (Washington: International Monetary Fund); also "Un modèle simple de zone monétaire optimale," *Economie et Prévision,* Vol. 128.

———, 1997c, "A Ricardian Model of New Trade and Location Theory," *Journal of Economic Integration,* Vol. 12 (March), pp. 47–61.

———, 1998, "Uncertainty, Flexible Exchange Rates, and Agglomeration," IMF Working Paper 98/09 (Washington: International Monetary Fund); also *Open Economies Review* (forthcoming).

———, 1999, "Economic Geography and Comparative Advantage: Agglomeration Versus Specialization," *European Economic Review,* Vol. 43 (February), pp. 357–77.

Tavlas, George, 1994, "The Theory of Monetary Integration," *Open Economies Review,* Vol. 5 (March), pp. 211–30.

Tille, Cedric, 2006, "On the Distributional Effect of Exchange Rate Fluctuations" *Journal of International Money and Finance* (forthcoming).