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Working Paper

Exchange rate regimes and location

Diskussionsbeiträge - Serie II, No. 291

Provided in Cooperation with:

Department of Economics, University of Konstanz

Suggested Citation: Ricci, Luca Antonio (1995) : Exchange rate regimes and location, Diskussionsbeiträge - Serie II, No. 291, Universität Konstanz, Sonderforschungsbereich 178 - Internationalisierung der Wirtschaft, Konstanz

This Version is available at:

<https://hdl.handle.net/10419/101619>

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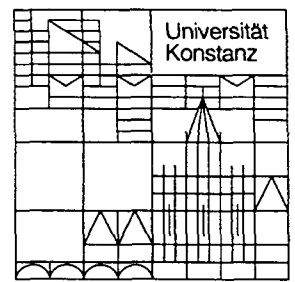
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Sonderforschungsbereich 178
„Internationalisierung der Wirtschaft“

Diskussionsbeiträge

Juristische
Fakultät

Fakultät für Wirtschafts-
wissenschaften und Statistik

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Exchange Rate Regimes and Location

24. JAN. 1996 Weltwirtschaft
Kiel

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W 113 (291)

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Serie II - Nr. 291

Dezember 1995

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Exchange Rate Regimes and Location¹

Abstract

This paper investigates the effects of fixed versus flexible exchange rate regimes on location choices of firms and on the degree of specialization of countries. In a two-country two-differentiated-good monetary model, demand, supply, and monetary shocks arise after wages are set and prices are optimally chosen. The exchange rate performs then an adjustment role for firms located in the country relatively specialized in the good they produce, but it constitutes a factor of disturbance for the others. As firms choose ex-ante the location that offers the higher expected profits for their industry, we find that countries are more specialized under flexible exchange rates than under fixed rates. One important implication is that the adoption of a fixed exchange rate regime increases the desirability of such a currency area, as it induces sectoral dispersion of production and consequently reduces the degree of asymmetry of shocks.

First draft May 1995

This version December 1995

¹ Previous drafts of this paper have been written while I was Visiting Fellow at the Department of Economics of Harvard University. I am grateful to Joshua Aizenmann, Richard Baldwin, Olivier Blanchard, Alessandra Casella, Francesco Caselli, Donald Davis, Guy Dumais, Hans Genberg, Jose' Gonzales, Paul Krugman, Philip Lane, Giovanni Maggi, Jeffrey Sachs, Carmelo Salleo, and Jaume Ventura for helpful discussions. I thank all the participants in conferences or workshops at The Graduate Institute of International Studies (Geneva, CH), Harvard University (Cambridge, MA, USA), IGIER (Milan, IT), Konstanz University (Konstanz, D), and La Sapienza University (Rome, IT). I am indebted to Edward T. Smith for invaluable help. Generous financial support from the Swiss National Research Funds is gratefully acknowledged. The usual disclaimers apply.

Introduction

This paper investigates the effects of alternative exchange rate regimes on location choices of firms and on the degree of specialization of countries. It emphasizes the short-run adjustment role of the exchange rate when shocks arise in the presence of short-run market rigidities. Such a role affects in a different way the expected profits of firms belonging to different sectors, generating incentives to relocate. Under flexible exchange rates, in fact, each firm has an incentive to locate in the country whose aggregate shocks to net exports are positively correlated with the firm's shocks, so that the endogenous exchange rate movements would bring adjustment and not disturbance to the firm. Consequently, countries are more specialized under flexible exchange rates than under fixed rates. One important implication follows: the net-benefits that can be expected from the creation of a currency area are endogenous to -and rising with- the institution of the currency area, as the latter induces sectoral dispersion and consequently reduces the degree of asymmetry of shocks.

The core economic mechanism driving this result can be decomposed in three sequential steps: the different effects of the two exchange rate regimes on variability of sales; the relation between variability of sales and expected profits; the incentive to locate where expected profits are higher.

The intuition is as follows. Consider a world constituted by two countries (1 and 2) engaging in both intra- and inter-industry trade of two differentiated goods (A and B); country 1 is a net exporter of good A. The world is initially in equilibrium. After prices are chosen, assume a shift of demand from good B to good A. Under fixed exchange rates, the shock affects equally all firms producing the same good, regardless of their location. Under floating, however, currency 1 appreciates, as the shock hits asymmetrically the two countries. The consequent substitution effect reduces the initial increase of demand experienced by firms producing good A in country 1, but generates a further increase in the demand for varieties of good A produced in country 2 (analogously for industry B, provided that we substitute 1 with 2). Therefore, endogenous exchange rate movements provide a partial adjustment for the firms located in the country which is a net exporter of the good they produce, but generate further disturbance for the firms within the same industry located 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

of sales than their competitors.

Higher variability of sales results in lower expected profits in the presence of decreasing returns to scale and price rigidities, as the profit function becomes concave in output. Firms dislike variability of sales also in the presence of costs of firing workers, due for example to institutional regulations, or bankruptcy costs, such as legal fees, or costs of maintaining stocks of goods in order to smooth excess demands.

Even if price rigidities and shocks eventually fade away, new price rigidities and shocks will arise, and firms should expect the same scenario to occur over time. Under flexible exchange rates, therefore, firms have an incentive to locate in the country which is relatively specialized in the good they produce². Under fixed exchange rates, however, all firms face the same variability of sales regardless of their location, and no incentive to relocate arise. As a consequence, countries should be more specialized under flexible exchange rates than under fixed rates. This result implies that the pattern of specialization indicated by any trade model is not unique but depends also on the exchange rate regime. Moreover, it suggests that taking the location of production as exogenous when evaluating changes in exchange rate regime can be misleading. For example, the creation of a currency area makes countries less specialized, hence shocks less asymmetric, thereby reducing the costs of renouncing to the exchange rate as an instrument of adjustment.

The novelty of our result stems from the integration of basic elements of both trade theory and open macroeconomics. Trade theory usually neglects the existence of short-run market rigidities and assigns no role to the nominal exchange rate; the exchange rate regimes is therefore irrelevant for the pattern of specialization. Open macroeconomics deals extensively with market rigidities, but usually views countries as fully specialized (or implicitly producing "aggregates") and does not allow for an analysis of the sectoral impact of exchange rate movements. The interesting synergies arising from the combination of these two theoretical approaches are not often examined.

The existing literature on the relation between exchange rate regimes and location is inadequate to investigate the implications for the pattern of specialization. Most of the literature on firm's optimal choices under exchange rate uncertainty is based on a partial

² In the absence of a comparative advantage, an equilibrium location pattern under floating is attained only when countries are fully specialized. We will discuss this extreme outcome in sections 2 and 5.

equilibrium analysis of the behavior of a single firm. The main result is that when the exchange rate is more variable a risk averse firm will increase foreign direct investment (FDI; see Campa and Goldberg, 1993; Goldberg and Koldstad, 1994; Cushman, 1985) or will increase foreign production and decrease foreign sales (see Broll and Zilcha, 1992³, and Broll, Wahl, and Zilcha, 1995). However, this literature usually neglects the endogenous nature of the exchange rate and, failing to capture the heterogeneity of sectors of production in the economy, it does not allow us to infer how changes in FDI or in foreign production are related to changes in the pattern of specialization. Goldberg and Koldstad (1994) find that a positive correlation between the demand shocks faced by the firm and the depreciations of domestic currency raise FDI. However, such correlation is exogenous and there is no mention about what correlation (and therefore which behavior) is associated with other domestic firms and with foreign firms. Therefore we cannot infer which is the final equilibrium distribution of production.

Aizenman (1992) develops a two-country model with both real and monetary aspects and finds that under fixed exchange rates both domestic and foreign direct investment are higher than under flexible exchange rate (see Aizenmann -1994- for the implications on the welfare ranking of the two exchange rate regimes). Although his complex model has the merit of avoiding a partial equilibrium approach, countries' productions are homogenous and once again we cannot infer changes in the degree of specialization.

In order to improve upon the existing literature, we develop a two-country two-differentiated-good one-factor monetary model where: countries engage in both inter- and intra-industry trade; uncertainty arise from demand, supply, and monetary shocks; and the exchange rate is determined endogenously. 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. Within this framework, we investigate how endogenous movements in the exchange rate affect firms' sales and profits, generating incentives to relocate. Price rigidities, decreasing returns to scale and international labor immobility allow us to tailor this one period model towards the representation of the **short-run** adjustment to shocks. Although location choices are inherently long-run choices, an extension to a multiperiod framework would not alter qualitatively the results, as long as

³ When direct hedging is possible the 'separation result' holds and firm's production and sales decisions are independent of exchange rate uncertainty or of risk aversion.

every period some shocks arise after prices are chosen; similarly, the introduction of tradable financial assets could reduce the size of the incentive to relocate, but would not change the nature of the results (we will discuss again these points in section 5).

The rest of the paper is structured as follows. Section 1 describes the basic model with demand shocks. Section 2 employs the basic model to investigate the adjustment to demand shocks, the expected profitability, and the incentives to relocate faced by firms of different sectors within each country, under both fixed and flexible exchange rate regimes. It then infers the equilibrium location pattern under the two regimes. Section 3 shows how similar results hold in the case of monetary and supply shocks. A brief note on price and wage flexibility follows in section 4. Section 5 discusses the results and the implications of the paper.

1. The Basic Model (with demand shocks)

1.1. Structure of the model.

This model extends Blanchard and Kiyotaki (1987) to a two-country two-differentiated-good setup⁴. Consider a world constituted of two countries (**1** and **2**), which are inhabited by the same amount of individuals (**L**), and produce two types of goods (**A** and **B**). Each good is produced in **n** differentiated varieties (indexed by $i=1,...,n$ for good A and by $j=1,...,n$ 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 the same share η of the **n** firms in industry B are located in country 2. If $\eta=1/2$, countries would have an identical production structure; $\eta=0$ or $\eta=1$ would imply full specialization; we assume $1/2 < \eta < 1$ so that country 1 (2) is **relatively**

⁴ We leave out some of the features of the Blanchard and Kiyotaki's (1987) model. In the effort to keep our framework simple, we found unnecessary to replicate their endogenous wage setting, and therefore to employ differentiated labor supply and to introduce work in the utility function.

specialized in good A (B). Starting from such generic distribution of firms we will infer the incentive to relocate under different exchange rate regimes⁵. We define a **sector** as the part of an industry located in one country; there are therefore four sectors: **A1, A2, B1, B2**.

Uncertainty, timing of actions, and price setting.

Uncertainty arise from demand shocks (we will introduce monetary and productivity shocks in section 3).

Before the resolution of uncertainty, workers of each country set the domestic wage (w_k , $k=1,2$) and commit to supply as much labor as demanded by firms at this wage level⁶. As the initial wage and the associated employment in the absence of shocks are not relevant to our analysis (what matter are the fluctuations around such initial level), we assume for simplicity that the wage chosen would ensure full employment in the absence of shocks. In full employment, every worker supplies one unit of labor; as shocks arise, every worker supplies more or less of one unit of labor, depending on domestic firms' demand for such factor.

Firms observe the wage and choose optimal prices as markup over expected marginal costs⁷ (see section 1.2).

After the resolution of uncertainty, a new equilibrium in the goods and money markets is reached: taking for given wages and prices, firms choose optimal employment and output

⁵ This location of firms could be derived endogenously in different ways. In a world with two factors of production unequally distributed across countries one could assume that factors are industry-specific (as in Krugman, 1981) or employed in different proportions in the two industries (as in a standard Heckscher-Ohlin framework). In our one-factor model, one could to introduce trade costs and a Ricardian comparative advantage based on productivity differences (as in Ricci, 1995).

However, as we will discuss later, our inference on the relocation incentives under different exchange rate regimes would be unaltered. A previous draft contained a comparative advantage based on technological differences, trade costs and product differentiation, as in Ricci (1995): the resulting mathematical complication obscured the intuition and required simulations to present the results.

⁶ The introduction of domestic monopolistic unions could provide specific microfoundation for the wage setting process, while "transaction costs of frequent price setting and wage negotiations" (Fischer, 1977) may constitute the reason why wages do not respond to shocks; an example based on menu costs can be found in Blanchard and Kiyotaki (1987).

⁷ Menu costs or costs in the price-setting decision process may constitute the reason why firms do not change the price once shocks are known. As this paper focus on the adjustment to shocks in the presence of price rigidities and not on the persistence of unemployment associated with price rigidities even in the absence of shocks, introducing microfoundations for price and wage rigidities would just add unnecessary mathematical complication.

levels, consumers choose optimal consumption and money balances, and, under fixed exchange rate regimes, monetary authorities intervene to stabilize the exchange rate. Actual employment fluctuates around the full employment level.

Preferences and wealth

All individuals share the same utility function. A representative consumer⁸ of country k chooses nominal money balances (m'_k) and consumption of varieties of good A and B (c_{iAk} and c_{jBk} respectively) so as to maximize the following random preferences:

$$U_k = (C_{Ak}^\gamma C_{Bk}^{1-\gamma})^\lambda (m'_k / P_k)^{1-\lambda}, \quad 0 < \gamma < 1, \quad 0 < \lambda < 1$$

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 a random variable whose initial value is .5 and whose percentage change ($\mu_D = d\gamma/\gamma$) is bounded in $(-z_D, z_D)$ with mean 0 and variance u_D^2 .

The nominal wealth of a representative individual of country k (q_k) is the sum of his income (y_k) and of his endowment of domestic currency (m_k). His endowment of money is a fraction $1/L$ of the domestic stock of money, which may vary under fixed exchange rate because of monetary intervention (see below). Each individual supplies labor to domestic firms at the given wage and receives profits from these firms; his income is therefore a share $1/L$ of domestic firms' revenues. There are no assets. The consumer's budget constraint is:

$$\sum_{i=1}^n p_{iA}^k c_{iAk} + \sum_{j=1}^n p_{jB}^k c_{jBk} + m'_k = q_k \equiv m_k + y_k$$

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 .

⁸ As agents of different countries may face different prices and wealth, we need to distinguish them.

Market structure and technology.

The market structure is the usual large group monopolistic competition based on Dixit-Stiglitz (1977) and often adopted in trade theory thereafter (see Helpman and Krugman, 1985). In order to introduce price rigidities, however, we assume that firms play Bertrand before the resolution of uncertainty and, taking for given the chosen prices, choose optimal employment after the realization of the shocks.

Production functions are identical for all firms and exhibit diminishing returns to labor. The output (x_{ck}) of a typical firm⁹ producing a variety of good c ($c=A,B$) in location k ($k=1,2$) is given by:

$$x_{ck} = D_c l_{ck}^\alpha$$

where D_c is the productivity level of industry c , l_{ck} is the employment of such a firm, and α is a measure of the returns to scale. Decreasing returns to scale are ensured by $0 < \alpha < 1$. We assume that $\alpha = .5$; such assumption is not essential, but allows for extensive mathematical simplifications. In sections 1 and 2 we assume that $D_c = 1$ for both industries; in section 3 we will allow for productivity shocks.

Monetary rule

Monetary authorities are not allowed to pursue discretionary policies. In a fixed exchange rate regime, they are committed to adjust money supplies (M_k) in order to equilibrate the money market and eliminate any pressure on the exchange rate:

$$\frac{dM_k}{M_k} = v_{FIXk} \quad \forall k=1,2$$

In a flexible exchange rate regime monetary authorities abstain from such intervention and let the exchange rate adjust the money market and the trade balance. It is irrelevant to our results whether the fixed exchange rate regime is managed symmetrically or asymmetrically¹⁰; we choose to solve the model for the symmetric case.

⁹ All firms of the same sector ck face always the same situation and we do not need to distinguish among them.

¹⁰ In fact, in both cases the variability of sales is the same for all firms.

1.2. Equilibrium conditions

Consumer's behavior

Consumers observe the prices set by firms and, after the resolution of uncertainty, make their optimal choices. The solution to the consumer's maximization problem implies that individuals' demand for money, expenditure on good A, and expenditure on good B are respectively a share $(1-\lambda)$, $\lambda\gamma$, and $\lambda(1-\gamma)$ of their wealth. As all individuals of one country face the same prices and have the same homothetical utility function, we can easily derive the aggregate demands of country k for money (M'_k) and for each variety of good A produced in country f (A_{fk} , $f=1,2$) (the expressions for good B can be derived analogously):

$$A_{11} = \frac{P_{A1}^{-\sigma}}{P_{A1}^{1-\sigma}} \gamma \lambda Q_1 \quad ; \quad A_{21} = \frac{(e P_{A2})^{-\sigma}}{P_{A1}^{1-\sigma}} \gamma \lambda Q_1 \quad , \quad M'_1 = (1-\lambda) Q_1$$

$$A_{12} = \frac{(P_{A1}/e)^{-\sigma}}{P_{A2}^{1-\sigma}} \gamma \lambda Q_2 \quad ; \quad A_{22} = \frac{P_{A2}^{-\sigma}}{P_{A2}^{1-\sigma}} \gamma \lambda Q_2 \quad , \quad M'_2 = (1-\lambda) Q_2$$

with

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

$$Q_k = n_{Ak} P_{Ak} x_{Ak} + n_{Bk} P_{Bk} x_{Bk} + M_k = L q_k \quad \forall k=1,2$$

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 currency 1 for one unit of currency 2, and n_{ck} is the number of varieties of good c produced in country k . Under fixed exchange rates, only demands and wealth are subject to uncertainty; in a flexible exchange rate regime, also the exchange rate and the true price indexes are affected by the shocks. Consumers of different countries demand the same variety in different amounts when the exchange rate differs from one or when (nominal and real) wealth differs across countries.

Firms' behavior.

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 local currency) so as to maximize expected profits (π_{ck}):

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

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

$$x_{Ak}^d = A_{k1} + A_{k2} \quad , \quad x_{Bk}^d = B_{k1} + B_{k2} \quad \forall k=1,2$$

The optimal price (p_{ck}) is therefore set as a markup over expected marginal cost:

$$p_{ck} = \frac{\sigma}{\sigma-1} E \left[\frac{w_k}{\alpha} D_c^{-\frac{1}{\alpha}} x_{ck}^{d \frac{1-\alpha}{\alpha}} \right] = \frac{\sigma}{\sigma-1} E \left[\frac{w_k}{\alpha} \frac{l_{ck}^{1-\alpha}}{D_c} \right] \quad \forall c=A,B \ k=1,2$$

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 the firms will find it optimal to satisfy demand¹¹. The profit function is also concave in output, implying that firms dislike variability of sales.¹²

Equilibrium in the goods and money market.

Equilibrium in the goods market requires:

$$x_{Ak} = A_{k1} + A_{k2} \quad , \quad x_{Bk} = B_{k1} + B_{k2} \quad \forall k=1,2$$

Equilibrium in the money market (equivalent to balanced trade) is ensured by

¹¹ This is not true, however, for large increases in demand, which may be satisfied only at a marginal cost higher than the price. We rule out such possibility by assuming that the shocks are opportunely bounded.

¹² As we will discuss later, if prices are flexible, the profit function is linear in sales and firms are indifferent to the variability of sales.

exchange rate movements, in a flexible exchange rate regime, and by residual intervention of the monetary authorities (v_{FIXk}), in a fixed exchange rate regime.

1.3. Equilibrium in the absence of shocks.

In the absence of shocks, both sectors (A and B) face the same labor productivity and receive an identical aggregate expenditure, while both countries have the same money stock:

$$\gamma = 1 - \gamma = .5 \quad ; \quad D = 1 \quad ; \quad M_1 = e M_2$$

The only difference between the two countries is then given by their specular pattern of specialization (η). In equilibrium, in fact, both countries have the same wage, aggregate income, and aggregate wealth. All firms employ the same amount of labor, produce the same output, and charge the same price as markup over the same marginal cost evaluated at the firm's equilibrium employment level. As prices are equal, an identical share of expenditure will be allocated to each variety. Every consumer will consume all varieties in the same amount. Full employment is ensured by the wage level.

From the sections 1.1. and 1.2. we obtain, after normalizing the exchange rate and the price of each variety to 1:

$$p = e = 1$$

$$x = l^{\frac{1}{2}} = \left(\frac{L}{n} \right)^{\frac{1}{2}} = \frac{\lambda}{1-\lambda} \frac{M^R}{2n}$$

$$w = \frac{\sigma-1}{\sigma} \frac{1}{2 x}$$

$$\pi = \frac{\sigma+1}{2 \sigma} x$$

where M^R is the equilibrium world real stock of money.

2. Uncertainty, Incentive to Relocate, and Equilibrium Location.

2.1. Demand shocks.

We now perform a comparative static exercise to identify the effects of a change in the expenditure share between good A and B (μ_D). To preserve the concavity of the profit function, we do not linearize the production function.

As already described, before shocks are known, wages are set at the same level (w) in both countries, and prices are chosen as mark-up over expected marginal costs. As marginal cost is linear in output, whose expected value corresponds to its level in the absence of shocks, all firms choose the same price, equal to the certainty price, independently of their variability of output. Again we normalize this price to 1 ($p_{ck}=1$, $\forall c=A,B k=1,2$). Before shocks arise, therefore, the economy is described by the same set of relations that characterize the equilibrium in the absence of shocks (section 1.3). Assume now a shift in demand.

Fixed Exchange Rate Regime.

Under fixed exchange rates, the only effect is the direct demand effect of the change in expenditure shares. For example, in the case of a demand shift from B to A, all firms producing A (independently of where they are located) face the same rise in demand, and all firms producing B face the same fall in demand. The new goods market equilibrium is:

$$X_{Ak} = \mu_D \quad , \quad X_{Bk} = -\mu_D \quad \forall k=1,2$$

where $X_{ck} = dx_{ck}/x_{ck}$ is the percentage change in output of a typical firm producing good c in country k . The money market (hence the trade balance) is equilibrated by intervention of monetary authorities. Sectoral employment follows production.

Flexible Exchange Rate Regime.

The direct demand effect deriving from the change in tastes is now accompanied by the substitution effect due to the exchange rate adjustment. There is in fact an appreciation of the currency of the country (say 1), which is relatively specialized in the good (say A) whose demand rises. Such change in the exchange rate will induce consumers to substitute away from production of country 1 and in favor of production of country 2. The exchange

rate movement represents therefore a partial adjustment for sectors A1 and B2, but a further disturbance for sectors A2 and B1. In fact, firms producing A in 1 will see the initial increase in demand dampened by the exchange rate appreciation; on the other hand, firms producing A in 2 will see the initial increase in demand enhanced by the exchange rate depreciation (similar reasoning with opposite locations holds for industry B). The goods and money market equilibria require:

$$\varepsilon = -2(2\eta - 1)z\mu_D$$

$$X_{ck} = g_{ckD} \mu_D \quad \forall c=A,B \quad k=1,2$$

where $\varepsilon = de/e$, and

$$z = \frac{1}{1+4\eta(1-\eta)(\sigma-1)}$$

$$0 < g_{A1D} = -g_{B2D} = 2(1-\eta)\sigma z < 1$$

$$g_{A2D} = -g_{B1D} = 2\eta\sigma z > 1$$

Note that the exchange rate responds more to a given shock when countries are more specialized (higher η). This is because the exchange rate movement becomes both more necessary and less effective in the adjustment: in fact, the same shock is associated with larger trade and monetary imbalances, while the substitution effect induced by the exchange rate grows smaller because of the limited leverage that can be exerted on the small sector of each country. As intuitive, when countries have an identical production structure ($\eta=1/2$), they face symmetric shocks and the exchange rate is completely ineffective: the equilibrium is identical to the one under fixed exchange rates ($\varepsilon=0$, $X_{Ak} = -X_{Bk} = \mu_D$)¹³. Conversely, when countries are fully specialized ($\eta=1$, implying that sectors A2 and B1 do not exist anymore), the exchange rate brings full adjustment, as it generates the relative price movement required to reach a new equilibrium at unchanged quantities ($\varepsilon = -2\mu_D$, $X_{Ak} = X_{Bk} = 0$).

¹³ This situation corresponds to the Mundell's (1961) example of two countries (North and South) sharing equally two "product-regions" (East and West). These two countries constitute an optimal currency area even in the absence of international factor mobility, because of the ineffectiveness of the exchange rate.

2.2. The incentive to relocate.

Firms of a given industry have an incentive to choose ex-ante the location that offers the highest expected profits for that industry¹⁴. Starting from a generic initial distribution of location (described by η , see section 1.1) we investigate such an incentive under the two exchange rate regimes. Within each industry, the **incentive to relocate** from country k' to country k" can be measured by the difference between the expected profits for that industry in country k" and the expected profits for the same industry in country k'.

Fixed Exchange Rate Regime.

In such a regime all firms experience the same variability of output and therefore the same expected profits:

$$E [\pi_{ck}] = x - w E [x (1+X_{ck})]^2 = \pi - w x^2 u_D^2$$

where x and π are respectively the level of output and profits that would prevail in the absence of shocks. The larger the variability of the shocks (u_D^2) the lower the expected profits, because the profit function is concave in output (see section 1.2).

As all firms face ex-ante the same expected profits, in a fixed exchange rate regime there is no incentive to choose a different location.

Flexible Exchange Rate Regime.

By confronting the coefficients g_{ckD} derived in the previous section, we can infer that firms located in the country relatively specialized in their industry (i.e. firms producing varieties of A in 1 or of B in 2) face a lower variability of sales and higher expected profits than firms of the same industry located in the other country (A in 2 or B in 1):

$$E [\pi_{ck}] = x - w E [x (1+X_{ck})]^2 = \pi - w x^2 g_{ckD}^2 u_D^2$$

Therefore, in a flexible exchange rate regime, firms have an incentive to locate in the

¹⁴ Such reasoning is mostly appropriate when firms observe the exchange rate regime before choosing their location. When firms face a change in exchange rate regime, the incentive to relocate should be adjusted to account for relocation costs. This quantitative adjustment, however, would leave unaltered the qualitative nature of the results.

country relatively specialized in the good they produce: firms producing A have an incentive to locate in 1 while firms producing B have an incentive to locate in 2.¹⁵ Because of the mirror-image production structure, the "size" (absolute value) of the incentive to relocate is the same for the firms of the two industries. Such incentive to relocate (IR_D , where the subscript indicates the source of the shocks: demand) is therefore given by:

$$IR_D = E[\pi_{a1}] - E[\pi_{a2}] = E[\pi_{b2}] - E[\pi_{b1}] = w x^2 4 (2\eta - 1) \sigma^2 z^2 u_D^2$$

The incentive increases with the degree of specialization (η) and with the variance of the shocks (u_D^2). When countries are more specialized (higher η), the exchange rate moves more (see section 2.1) and generates a larger adjustment for the sectors of specialization of each country (A1, B2), reducing their already low variability of sales and raising the expected profits. The exchange rate movement enhances however the effect of the shocks on the sales of the other sectors (A2, B1), whose firms face even lower expected profits.

2.3. Equilibrium Location of Firms.

A distribution of firms across countries is an equilibrium location pattern if no firm has an incentive to choose a different location, i.e. if expected profits are equal for all firms. From the previous section 2.2, we can infer that in this simple model the equilibrium location of firms under fixed exchange rates is given by the initial distribution of firms, while under floating is given by full specialization. This extreme result is due to the exogenous nature of the initial distribution of firms (η). In section 5 we discuss how the introduction of a comparative advantage would prevent such extreme outcome while preserving the main result that countries are more specialized under flexible than under fixed exchange rates.

¹⁵ Even if our framework is static and price rigidities will eventually fade away, it is conceivable that the same incentive to relocate would arise in an intertemporal framework where our static scenario repeats over time: every period, wages and prices are chosen before new shocks are known; price rigidities and shocks last one period. We will come back to this point (see section 5).

3. Other Sources of Uncertainty

We now want to show that monetary and productivity shocks give rise to the same incentive to relocate.

3.1. Monetary shocks.

This section is particularly interesting both because a substantial amount of short-run exchange rate variability is of monetary nature, and because on a first thought one would not envision sectoral relocation effects arising from monetary shocks.

Assume that the economy is now disturbed by national monetary shocks which take the form of percentage changes in the initial money stock ($\mu_{Mk} = dM_k/M_k$) and are bounded in $(-z_M, z_M)$ with mean 0 and variance u_M^2 (we assume equal variance across countries). Money supply of country k would now change both because of monetary shocks (μ_{Mk}) and, in a fixed exchange rate regime, because of the residual authorities' intervention (v_{FIXk}) to equilibrate the money market:

$$\frac{dM_k}{M_k} = \mu_{Mk} + v_{FIXk} \quad \forall k=1,2$$

As for the case of demand shocks, firms' expected marginal cost is equal to its value in the absence of shocks and therefore the initial equilibrium is again described by the set of equations presented in section 1.3.

Fixed Exchange Rate Regime.

Any change in money stock is reflected into 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 of sales and the same expected profits:

$$X_{ck} = (\mu_{M1} + \mu_{M2}) / 2 \quad \forall c=A,B \quad k=1,2$$

$$E[\pi_{ck}] = x - w E[x(1+X_{ck})]^2 = \pi - w x^2 u_M^2 (1+\rho_M) / 2$$

where ρ_M is the coefficient of correlation between the monetary shocks of the two countries,

and u_M^2 represents their common variance.

Again, under fixed exchange rates, there is no incentive to choose a different location and the initial distribution of firms is an equilibrium.

Flexible Exchange Rate Regime.

In addition to the wealth effects there is the substitution effect associated with the depreciation of the currency which has become relatively more abundant. The exchange rate movement induces an expenditure shift across countries. Each firm belonging to the small sector of each country will bear a larger share of such expenditure shift than a firm located in the country specialized in the good they produce. The equilibrium in the goods and money market is given by:

$$\varepsilon = z (\mu_{M1} - \mu_{M2})$$

$$X_{ck} = (\mu_{M1} + \mu_{M2}) / 2 + g_{ckM} (\mu_{M1} - \mu_{M2}) \quad \forall c=A,B \ k=1,2$$

$$g_{A1M} = -g_{B2M} = [1 + 2 (1-\eta) (\sigma-1)] z / 2$$

$$g_{B1M} = -g_{A2M} = [1 + 2 \eta (\sigma-1)] z / 2 > g_{A1M}$$

Within each industry, firms located in the country relatively specialized in that industry (i.e. producing A in 1 or B in 2) face a lower variability of sales and higher expected profits:

$$E[\pi_{ck \text{ FLEX}}] = x - w E[x (1 + X_{ck})]^2 = \pi - w x^2 u_M^2 [1 + \rho_M + 4g_{ckM}^2 (1 - \rho_M)] / 2$$

As in the case of demand shocks, firms have an incentive to locate in the country relatively specialized in the good they produce; such incentive (IR_M) raises with the degree of specialization (η) and with the variance of monetary shocks (u_M^2), and decrease with the correlation of the shocks (ρ_M):

$$IR_M = w x^2 2 (2\eta - 1) (\sigma - 1) \sigma z^2 u_M^2 (1 - \rho_M)$$

As in section 2, under floating, the only equilibrium location pattern is full specialization.

3.1. Supply shocks.

We now show that productivity shocks are similar to demand shocks in their sectoral effects on sales and profits, and therefore in the incentive to relocate that they induce.

The productivity of industry c (D_c) takes initially the level of 1 and its (absolute and percentage) change ($\mu_{sc}=dD_c$) is bounded in $(-z_s, z_s)$ with mean 0 and variance u^2_{sc} . We introduce a monetary rule justified by the presence of price rigidities: monetary authorities adjust domestic money supply (v_{sk}) by the change in average domestic productivity in order to accommodate changes in expenditure¹⁶. Money supply of country k would now change because of the accommodation (v_{sk}) and, in a fixed exchange rate regime, because of the intervention (v_{FIXk}) in order to equilibrate the money market:

$$\frac{dM_k}{M_k} = v_{sk} + v_{FIXk} \quad \forall k=1,2$$

$$v_{S1} = \eta \mu_{SA} + (1-\eta) \mu_{SB} \quad , \quad v_{S2} = (1-\eta) \mu_{SA} + \eta \mu_{SB}$$

In order to enlighten the intuition without entering heavy mathematical complexity, we neglect that under flexible exchange rates firms of different sectors should choose different prices¹⁷. We simply assume that each firm sets the price at its optimal level in the absence of shocks, so that the initial equilibrium is described by the set of equations presented in section 1.3 and is therefore equal to the usual initial equilibrium for the cases of both demand and monetary shocks. Let us now describe the effects of productivity shocks.

Fixed Exchange Rate Regime.

The monetary accommodation allows expenditure on all goods to change by the world average productivity growth. At initial employment levels, firms in the industry whose productivity has risen relatively more would be in excess supply of goods; they therefore

¹⁶ In the absence of such monetary rule, productivity shocks would have no effect on output (but only on employment). The expected size of each accommodation is zero, as the changes in productivity have a zero mean.

¹⁷ Marginal costs is no more linear in shocks (as it was, instead, with demand and monetary shocks), and firms of different sectors face different variability of sales under flexible rates.

reduce employment. Conversely for the other sector. As usual under fixed exchange rate regime, no incentive to relocate arises, and the initial location structure is an equilibrium: all firms experience in fact the same variability of sales and expected profits:

$$X_{ck} = (\mu_{SA} + \mu_{SB}) / 2 \quad \forall c=A,B \ k=1,2$$

$$E [\pi_{ck}] = x - w E [x (1 + X_{ck} - \mu_{Sc})]^2 = \pi - w x^2 (u_{SA}^2 + u_{SB}^2 - 2\rho_S \mu_{SA} \mu_{SB}) / 4$$

Flexible Exchange Rate Regime.

The country whose average productivity rises relative to the one 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 (i.e. firms belonging to sectors A1 and B2), as it helps absorbing their (positive or negative) excess supply and reduces their need for a change in employment. The same substitution effect, however, constitutes an element of further disturbance for the other firms (belonging to sectors A2 and B1), by enhancing their excess supply and employment change. The similarity with the demand shocks case is striking. In the new goods and money market equilibrium, the changes in output due to changes in employment are:

$$X_{ck} - \mu_{Sc} = g_{ckS} (\mu_{SA} - \mu_{SB}) \quad \forall c=A,B \ k=1,2$$

$$0 < g_{B2S} = -g_{A1S} = (1-\eta) \sigma z < \frac{1}{2}$$

$$g_{B1S} = -g_{A2S} = \eta \sigma z > \frac{1}{2}$$

Within each industry, firms located in the country relatively specialized in that industry experience a lower variability of sales and higher expected profits:

$$E [\pi_{ck \text{ FLEX}}] = x - w E [x (1 + X_{ck} - \mu_{Sc})]^2 = \pi - w x^2 g_{ckS}^2 (u_{SA}^2 + u_{SB}^2 - 2\rho_S \mu_{SA} \mu_{SB})$$

The usual incentive to relocate arises. It increases with the degree of specialization (η) and with the variances of the productivity shocks (u_{Sc}^2); it decreases with the correlation of the shocks (ρ_S):

$$IR_S = w x^2 (2\eta - 1) \sigma^2 z^2 (u_{SA}^2 + u_{SB}^2 - 2\rho_S u_{SA} u_{SB})$$

Again, in a flexible exchange rate regime, the equilibrium location of firms is given by full specialization.

4. Note on price and wage flexibility.

If prices are flexible, the profit function is linear in sales ($p_{ck} x_{ck}$), both with fixed and flexible wages¹⁸. In fact, recalling the optimal pricing rule (in actual terms), we obtain:

$$w_k l_{ck} = \alpha \frac{\sigma - 1}{\sigma} p_{ck} x_{ck}$$

hence

$$\pi_{ck} = \left(1 - \alpha \frac{\sigma - 1}{\sigma}\right) p_{ck} x_{ck}$$

It is however reasonable to think that concavity in the production function and short-run price rigidities is not the only reason why firms dislike variability of sales. In fact, we already mentioned in the introduction other reasons such as firing, inventory, and bankruptcy costs. We can also conceive that firms would behave as risk averse if the owners are risk averse and face incomplete financial markets, or if managers are risk averse and face imperfect labor market or get non-marketable payoffs (such as satisfaction, reputation,...). In all these cases, firms would still be sensitive to the variability of sales. We therefore briefly discuss the adjustment to demand and monetary shocks¹⁹ in two cases. Case 1: price flexibility but wage rigidity. Case 2: price and wage flexibility.

¹⁸ Note that this outcome is independent of our choice of $\alpha=0.5$.

¹⁹ With flexible prices, the adjustment to supply shocks is trivial. Independently of the rigidity in wages and of the exchange rate regime, price movements fully adjust the productivity shocks (in the presence of price flexibility, it is no more reasonable to assume that monetary authorities accommodate the shocks). All new levels of output at initial employment levels are demanded at new prices. All firms face zero variability of sales and have the same profits.

Price flexibility but wage rigidity.

Fixed exchange rates. With demand shocks, prices and quantities change, in absolute value, by the same percentage for all varieties. With monetary shocks, prices and quantities change equally for all varieties. Therefore, in the occurrence of both kinds of shocks, all firms face the same variability of sales, and no incentive to relocate arises.

Flexible exchange rates. With demand shocks, the country which is a net exporter of the good whose demand rises experiences a depreciation of its currency. With monetary shocks, the currency which becomes relatively more abundant depreciates. In both cases, the usual sectoral pattern of variability of sales occurs, and firms have the usual incentive to locate in the country relatively specialized in the good they produce.

Price and wage flexibility.

In this case, monetary shocks involve only nominal adjustment and do not induce relocation incentives, independently of the exchange rate regime. We therefore discuss the occurrence of demand shocks.

Fixed exchange rates. The country specialized in the good whose demand rises experiences a wage increase to restore full employment. Viceversa for the other country. Such relative wage adjustment is incorporated into the optimal prices and generates a substitution effects similar to the one arising under "flexible" exchange rates with price rigidities (see section 2.1): hence firms producing A in 1 and B in 2 experience a lower variability of sales than other firms. For the first time, an incentive to relocate arises under fixed exchange rate regime, and it is of the same kind usually associated with floating rates: firms prefer to locate in the country relatively specialized in the good they produce.

Flexible exchange rates. The monetary disequilibrium induced by the relative change in national nominal incomes is no more corrected by intervention of monetary authorities. The relative change in money stocks required to restore equilibrium must therefore occur through an exchange rate adjustment²⁰. The difference in the sectoral variability of sales already induced by the relative wage adjustment (as under fixed exchange rates) is enhanced by the new substitution effect. The incentive to relocate is therefore stronger than under fixed exchange rates.

²⁰ Note that even with fully flexible prices and wages, the exchange rate has to adjust. In fact, no change in the prices of goods can generate a relative change in national money stocks.

Summing up

We conjecture that demand and monetary shocks in case 1 should give the usual result: under flexible rates, firms would like to locate in the country specialized in the good they produce; under fixed rates such incentive is inexistent. Demand shocks in case 2 should generate this same incentive under both regimes, the one under flexible rates being stronger.

5. Results and Implications.

This paper finds that fixed and flexible exchange rate regimes are associated with different location incentives when demand, supply, and monetary shocks arise in the presence of short run price rigidities. Under flexible exchange rate, each firm has an incentive to locate in the country whose aggregate shocks to net exports are positively correlated with the firm's shocks, so that the exchange rate would constitute for the firm an instrument of automatic adjustment and not a further disturbance. Such a relocation incentive is inexistent under fixed exchange rates. Countries should therefore 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 specialized in the good they produce, and generate further disturbance to the other firms. When (domestic or foreign) monetary shocks arise, flexible rates ensure that the effect is softer for the former firms and larger for the latter ones. As a consequence, under flexible rates, the firms of a given industry which are located in the country relatively specialized in that industry experience lower variability of sales and higher expected profits than their competitors. Therefore, flexible rates provide to each firm an incentive to locate in the country relatively specialized in the good the firm produces²¹. Such incentive to relocate rises with the degree of specialization of countries and with the variance of shocks; it decreases with the correlation of real shocks between industries or of monetary

²¹ Our model neglects the existence of financial assets. However, the qualitative nature of our results would still hold as long as contingent claims market are incomplete; in the presence of perfect international equity markets, the results hold (for supply and monetary shocks) if firms maximize expected profits. Such (or more restrictive) assumptions are commonly adopted in the analysis of exchange rate regimes or of location choices.

shocks between countries.

We adopt a static framework with short-run price rigidities to investigate a decision, the choice of location, whose horizon goes well beyond the short run. However, it seems likely that a dynamic extension of our model would not alter the nature of our findings, as long as every period the temporal order of wage setting, resolution of uncertainty, and trading is preserved. In fact, one can conceive a version based on intertemporal optimization where the scenario we outlined repeats over time: every period, wages are set and prices are optimally chosen before the resolution of uncertainty; shocks last one period (permanent shocks would otherwise be adjusted at the end of the period they occurred). In the absence of financial capital flows across countries, the results would be equivalent to the ones derived in our static model, once adjusted for net present value calculations. In the presence of capital mobility, both the exchange rate movements and the incentive to relocate would be dampened. In either case, the qualitative nature of our conclusions would still hold.

Our findings imply that the pattern of specialization indicated by any trade model is not unique but depends also on the exchange rate regime. If our model were to be taken literally, in a fixed exchange rate regime any initial location structure (η) would be an equilibrium distribution of firms (i.e. a distribution of firms such that firms have no incentive to relocate); under flexible exchange rates, however, an equilibrium distribution of firms would arise only when countries are fully specialized ($\eta=0$, or $\eta=1$). A more realistic scenario could be obtained by introducing a comparative advantage or other trade theoretical justifications for the initial location pattern (see section 1.1). In such an extension the equilibrium location distribution under fixed exchange rates would be dictated only by the comparative advantage. Under flexible exchange rates, however, the occurrence of shocks in the presence of price rigidities would still generate the described incentive to deviate from the location distribution induced by the comparative advantage: the equilibrium location distribution could therefore be determined by weighing, for the marginal firm, the incentive to relocate in order to benefit from the adjustment role of the exchange rate, against the efficiency loss associated with the departure from the location dictated by the comparative advantage. It is curious to note that in the presence of shocks and price rigidities, the fixed exchange rate regime, and not the flexible one, gives the same location structure as a trade model which neglects all short run rigidities and where money is a veil.

In the absence of price rigidities, the profit function is linear in sales, whose variability

becomes indifferent to the firm. If however one would account for other reasons why firms care of variability of sales (such as firing, inventory, and bankruptcy costs), it should be inferred that flexible exchange rates are still associated with larger specialization, even in the presence of price flexibility (see section 2.4).

This paper presents a clear-cut implication for the choice of exchange rate regime and the optimum currency area literature. The net-benefits that can be expected from the creation of a currency area are endogenous to (and rising in) the institution of the currency area, as the latter induces industrial dispersion and consequently reduces the degree of asymmetry of shocks. Kenen (1963) argued that more diversified economies are better candidates for a currency area. Our paper argues that there may exist also a reverse relation: the creation of a currency area will make member countries more diversified.

The literature on optimum currency areas stresses that the net-benefits that can be expected to derive from the creation of a currency area depend on several factors²², and particularly on the degree of symmetry of shocks. On the basis of these factors, such literature suggests that a cost-benefit analysis of the creation of a currency area could be done by looking at the fundamentals and at the structural parameters of the candidate economies, failing to capture that some of these elements may be endogenous to the creation of the currency area itself. This paper argues that different exchange rate regimes are associated with different location choices of firms, which in turn alter the degree of symmetry of shocks across countries. Consequently, the creation of a currency area affects the fundamentals on which the desirability (as measured by the net-benefits) of the same currency area depends. This paper therefore extends the optimum currency area literature.

²² Such as the degree of asymmetry of shocks, the rigidities in prices and wages, the international mobility of factors, the availability of fiscal stabilization tools, the degree of openness and diversification of the economies, the different inflationary bias of domestic authorities, and, in the case of a currency union, the deadweight and efficiency gains deriving from the adoption of a single currency.

See Ricci (1994) for a two-country model that comprehends most of monetary and real aspects of this analysis, Bayoumi (1994) for an n-country model discussing most of the real aspects. For surveys of the OCA literature, see: Bofinger (1994), De Grauwe (1992), Ishiyama (1975), Krugman (1992), Masson and Taylor (1992), Tavlas (1993, 1994), and Tower and Willet (1976).

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