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A FORMAL MODEL OF OPTIMUM CURRENCY AREAS

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ABSTRACT

A Formal Model of Optimum Currency Areas*

A model of optimum currency areas is presented using a general equilibrium model with regionally differentiated goods. The choice of a currency union depends upon the size of the underlying disturbances, the correlation between these disturbances, the costs of transactions across currencies, factor mobility across regions, and the interrelationships between demand for different goods. It is found that while a currency union can raise the welfare of the regions within the union, it unambiguously lowers welfare for those outside the union.

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NON-TECHNICAL SUMMARY

The set of existing or prospective currency unions has changed significantly over a short space of time. Plans for European Monetary Union (EMU), the break-up of the monetary unions in Czechoslovakia, the former Soviet Union and Yugoslavia, and the reunification of the two halves of Germany into a single currency zone have all contributed to this change. One of the effects of this has been to reignite interest in the characteristics of a beneficial, or optimum, currency area.

The literature on optimum currency areas was initiated by Mundell (1961). Mundell argued that, while the 'costs of valuation and money-changing' were lower within a currency union, fixing the rate of exchange across regions by forming a currency union was costly in the face of asymmetric disturbances and price rigidities. These costs could be alleviated if a high level of factor mobility existed between regions, however. Hence, he viewed factor mobility as the key criteria in the choice of a currency union. McKinnon (1963) argued that openness to external trade should be another important criterion. If an economy was very open, a flexible exchange rate would be relatively ineffective, since changes in the exchange rate would destabilize the internal price level and have few beneficial effects on real wages or the terms of trade. Hence, currency unions that were relatively closed with respect to the rest of the world were to be preferred. Finally, Kenen (1969) argued that regions with high product diversification would be able to maintain a currency union more easily than those with low diversification since the latter are subject to larger disturbances.

These three papers represent the core theory of optimum currency areas and have been the basis for much of the recent empirical work. As might be expected from contributions dating back to the 1960s, however, they offer verbal arguments rather than formal models. This paper presents a formal model of optimum currency areas. The world is assumed to consist of a number of different regions, each of which produces a different good and has sticky nominal wages. Each region can choose to have a separate currency or to join some of the other regions in a larger currency union. The advantage of joining a currency union is that transactions costs with other regions in the union are lower. The disadvantage comes from the fact that the exchange rate can no longer be used to offset asymmetric disturbances within the currency union, resulting in output losses. The analysis highlights the trade-off between these two factors.

The result is a flexible framework which embodies many of the criteria for optimum currency areas suggested in the original papers by Mundell, McKinnon, and Kenen, including such factors as the size of underlying disturbances, the degree of correlation between the disturbances across regions, the costs of

transactions between different currencies, the level of factor mobility across regions, and the interrelationship of demand between regions.

The model also provides some insights on the welfare effects of currency unions. The most interesting insight is that, while a currency union can raise welfare of the regions within the union, it unambiguously lowers welfare for regions outside of the union. This is because the gains from the union, in the form of lower costs of transacting business, are limited to the members of the union, while the losses from the union, in the form of lower output due to the interaction between the common exchange rate and the nominal rigidity, affect everybody. Hence, regions outside of the union partake in the costs of the union but not in the benefits. This conclusion does depend on some of the underlying assumptions used in the model, but it is a useful reminder that the impact of a currency union need not be benign to those excluded.

Another insight is that the incentives for a region to join a currency union are different from the incentives to admit a region into a union. The entrant gains from lower transactions costs on trade with the entire existing union, while the incumbent regions only gain on their trade with the potential entrant. As a result, a small region will always have a greater incentive to join a union than the union will have an incentive to admit the new member. A corollary of this is that, even if a country would prefer a free float across all regions, it may still have an incentive to join a currency union with other regions if it is going to be formed. This is because most of the welfare losses from the nascent union will occur whether or not the region decides to join. This set of incentives may explain why some countries in the European Union who are not particularly convinced of the merits of European Monetary Union are also worried about being relegated to the second division of a two-speed EMU.

I. Introduction

After a long period of relative stability, the set of existing or prospective currency unions has changed significantly over a very short space of time. Plans for European Monetary Union (EMU), the break-up of the monetary unions in the former Soviet Union, Yugoslavia, and Czechoslovakia, and the reintegration of the two halves of Germany into a single currency zone have all contributed to this change. One of the effects of this has been to reignite interest in the characteristics of a beneficial, or optimum, currency area.

The literature on optimum currency areas was initiated by Mundell (1961). 1/ Mundell argued that, while the "costs of valuation and money-changing" were lower within an currency union, fixing the rate of exchange across regions by forming a currency union was costly in the face of asymmetric disturbances and price rigidities. However, these cost could be alleviated if a high level of factor mobility existed between regions. Hence, he viewed factor mobility as the key criteria in the choice of a currency union. McKinnon (1963) argued that openness to external trade should be another important criterion. If an economy was very open a flexible exchange rate would be relatively ineffective, since changes in the exchange rate would destabilize the internal price level and have few beneficial effects on real wages or the terms of trade. Hence, currency unions that were relatively closed with respect to the rest of the world

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1/ This was largely a response of the wider debate on the value of fixed and flexible exchange rates (Friedman, 1953). Recent work on the choice of exchange rate regimes, such as Canzoneri (1982), have some features in common with the optimum currency literature. Flood and Marion (1992) provide a survey.

were to be preferred. Finally, Kenen (1969) argued that regions with high product diversification would be able to maintain a currency union more than those with low diversification since the latter are subject to larger disturbances. 1/

These three papers represent the core theory of optimum currency areas and have been the basis for much of the recent empirical work. 2/ However, as might be expected from contributions date back to the 1960s, they present verbal arguments rather than formal models. The object of this paper is to augment the existing literature by presenting a formal model of optimum currency areas using a general equilibrium model with regionally differentiated goods. Deriving the theory of optimum currency areas from a general equilibrium model of trade allows the various criteria which have been suggested for assessing currency unions to be integrated and compared.

Clearly, other papers have been written on the theory of optimum currency areas since 1969. 3/ The model presented in this paper differs from this existing literature in its use of a general equilibrium approach

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1/ See Ishiyama (1972), Masson and Taylor (1993), and Tavlas (1993a,b) for surveys of the optimal currency area literature.

2/ Much of this work has been on EMU. Eichengreen (1992) and Bean (1992) provide surveys of this literature which includes work on the nature of the underlying shocks, and factor mobility, and well as other mechanisms to alleviate asymmetric shocks such as federal fiscal policy. There is much less work on other regions. Bayoumi and Eichengreen (1994) provide some results across a wider set of geographic regions.

3/ Tavlas (1993a,b) surveys this literature. Many of the issues discussed there are not dealt with in the relatively simple framework adopted here. These include, the effectiveness of monetary policy, the role of political preferences, time inconsistency, and fiscal policy in the choice of regime, the speed with which external adjustment effects the domestic economy, and the relationship between the regime and the speed of adjustment. Like this paper, Melitz (1991, 1993) has tried to integrate the theory of optimum currency areas more with the theory of international trade.

and stronger microeconomic foundations. In addition to clarifying the analysis, these microeconomic foundations make it possible to analyze the incentives involved in forming a currency union in more detail than in earlier papers.

The rest of the paper is organized as follows. The next section outlines the structure of the model, while Section III analyzes the resulting equilibria. This is done by comparing the results from a fully floating exchange rate regime with the results from a currency union made up of two regions, and finally the results from a currency union made up of any number of regions. Particular emphasis is put on the welfare effects of the different regimes, both for regions within and outside of the currency union. Section IV looks at how the model relates to the various criteria for choosing currency unions outlined in the literature, while Section V concludes.

II. The Model

The model is based on a small general equilibrium model with regionally differentiated goods. It has four features that are worth noting at the outset, since they define the issues that the model does and does not address. First, the model assumes a nominal rigidity; wages can rise in periods of excess demand, but they cannot fall below a certain level in periods of low demand. While not uncontroversial, the existence of nominal rigidities is central to most considerations of currency unions; with fully flexible prices the costs of joining a currency union become minor, making the analysis of the issue of optimum currency areas largely pointless.

Second, the model has no explicit role for financial assets or government policy, so issues such as financial integration or the conduct of monetary or fiscal policy are not discussed. Third, each region is assumed to be fully specialized in production of one particular good. Hence, no account is taken of differential shocks to industries within a region. 1/ Finally, in order to provide a closed-form solution to the model simple functional forms such as logarithmic utility have been used. The advantage of this approach is that it allows the resulting model to be analyzed in more depth, but at the inevitable cost of generality.

Production

Consider a world with a number of different regions, each of which has the same underlying economic structure but produces a different variety of good. Each region has a fixed amount of labor which can be used to produce its particular good (the assumption that labor cannot move between regions will be relaxed later). The production function for region i is,

$$Y_i = L_i^{\alpha} e^{\epsilon_{it}} \tag{1}$$

where Y_i is the output of the good of region i, L_i is the input of labor in the region, α is a parameter which is less than 1 and ϵ_{it} is a disturbance which is normally distributed with a mean of zero and is independent of the exchange rate regime. Letting small case letters represent logarithms this can be rewritten,

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1/ Clearly, exchange rate policy cannot respond to disturbances of this type. This is discussed further in Melitz (1991).

$$y_i = \alpha l_i + \epsilon_i. \qquad (2)$$

The maximum amount of labor available in a region is 1, so $L_i \leq 1$. Region 1 is different from the other regions in that the productivity disturbance ϵ_{1t} is always equal to 0, and hence the full employment level of output Y_1 is 1 ($y_i = 0$). The price of output in region 1 (P_1) is the numeraire; $P_1 = 1$. 1/

Labor market

Labor is supplied in a competitive market, with real wage ($W_i/P_i\ E_i$) (where W_i is the wage in local currency and E_i is the bilateral exchange rate with region 1) equal to the marginal product of labor,

$$w_i - p_i + e_i = \log(\alpha_i) + \epsilon_{it} - (1-\alpha) l_i \qquad (3)$$

Nominal wages are assumed to be sticky in the following sense. The response of the wage in terms of local goods prices, W_i, depends upon the state of excess demand in the labor market when the wage is at a "normal" level, $\omega = \alpha$, defined as the wage which ensures full employment when there is no productivity shock ($\epsilon_{it} = 0$) and the exchange rate E_i is normalized to 1. If there is excess demand for labor at this point then the nominal wage is raised to the level which is consistent with full employed ($L_i = 1$). On the other hand, if labor demand is below the full employment level when $W_i = \omega$ then the wage is assumed to remain at this high level, and some labor is unemployed. 2/ Hence, there is an asymmetry between the labor market response to excess demand and excess supply.

1/ The assumption that region 1 has no productivity disturbance simplifies the definition of the numeraire, but has no other importance in the model.

2/ This type of adjustment is similar to that assumed in the disequilibrium models originated by Clower (1967).

This labor market assumption has an important interaction with the exchange rate regime. If the region has a nominal exchange rate that is free to adjust in response to underlying disturbances, then the wage is always set at the "normal" level, and movements in the exchange rate ensure that full employment is attained. By contrast, when the nominal exchange rate is not free to adjust fully because the region is part of a larger currency union, then the rigidity in the labor market implies some loss in output through unemployment.

Exchange rates

Each region has to chose its exchange rate regime with the other regions. If region i chooses a separate currency from region j then the ratio E_i/E_j is allowed to vary. However, the cost of this flexibility is that there is a cost to transactions between the two currencies. 1/ This cost is modeled using the "iceberg" model of trade, in which the goods that emanate from region j shrink by a factor $(1-T_j)$ on arrival in region i. For simplicity the cost T is assumed to be the same for all external transactions. If regions i and j chose to form a currency union then the ratio E_i/E_j is fixed at unity, and a common exchange rate E_{ij} is adopted. Because there is no longer any need to transfer currencies, the transactions cost is now zero (for simplicity transportation costs between regions are ignored).

For a currency union involving several regions, the exchange rate for the region as a whole is assumed to equal the geometric average of the

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1/ This represents all the costs of transferring from one currency to another, including those associated with transactions, different units of account, and legal and institutional differences between currency unions.

exchange rates for the individual regions if their exchange rates were freely floating (i.e., the exchange rates implied by full employment with wages equal to the "normal" level of ω). This assumption appears reasonable and provides a simple closed-form solution; however, it has no concrete microeconomic foundations. 1/

Demand

The production technology is assumed to be owned locally, hence the income for the region is equal to the nominal product, $Y_i P_i$. Consumption in region j is based on a Cobb Douglas utility function over all goods,

$$U_j = \sum_{i=1}^{N} \beta_{ji} \log(C_{ji}) - \phi, \tag{4}$$

where C_{ji} is the consumption of good i in region j and ϕ is a constant term equal to the sum of $\beta_{ji}\log(\beta_{ji})$. 2/

The β_{ji} coefficients are assumed to satisfy two criteria, both of which are normalizations. First, the sum of β_{ji} over i are equal 1 for all j, hence the coefficient β_{ji} represents the proportion of income in region j which is spent on good i. The second normalization is that the sum of β_{ji} over j are equal 1 for all i; this ensures that the aggregate demand for each product is symmetrical. From the form of the utility function it follows that at the point of production 3/ demand for the good i from region j is given by,

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1/ The assumption about the determination of the exchange rate does affect the results since there is a nominal rigidity in the model.

2/ The ϕ term simplifies the analysis later.

3/ Since the transactions costs are modeled using the "iceberg" assumption the demand for goods at the point of production need not be equal to consumption at the point of delivery.

$$Y_{ji} = \beta_{ji} P_j Y_j / P_i. \tag{5}$$

These assumptions can be shown to imply that all regional incomes are equal to unity. To see this assume the result. Since the sum of the β_{ji} coefficients over j are 1 for all i implies that the demand for good i at the point of production is,

$$Y_i = \sum_j \beta_{ji} / P_i = 1/P_i. \tag{6}$$

Equation (6) does indeed imply that all regional incomes ($P_i Y_i$) are equal to unity, confirming the initial assumption.

If the two regions are not in a currency union then the volume of goods consumed in region j is less than the volume of goods demanded at the point of production i, due to the impact of transaction costs. From equation (5) consumption of good i in region j is,

$$C_{ji} = \beta_{ji}(1-T_j)/P_i, \tag{7}$$

where T_j is equal to T for regions outside of the currency union and zero for regions within the currency union. 1/

The use of Cobb-Douglas preferences is clearly restrictive. The advantage of this approach is that it simplifies the analysis by eliminating the impact of income effects, thereby making it more tractable. The disadvantage is the loss of generality. In particular, since the productivity disturbance has no effect on regional income measured in terms of the numeraire (the change in output being exactly offset by the change in

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1/ The consumption price for good i in region j is $P_i/(1-T_j)$. Consumption prices for good i can differ across regions because of transaction costs; they are only equalized at the point of production.

local prices) it is important for the model that nominal wages in a region are set with respect to local prices rather than the numeraire. This distinction would not be so important in a more general model with an intertemporal elasticity of substitution of less than one.

III. Equilibrium

No currency areas

Consider first the situation in which all of the regions allow their currencies to float against each other. Since all of the exchange rates are fully flexible, nominal wages in local goods, W_i, are set at the "normal" level ω. Full employment implies that the exchange rate $e_i = \epsilon_{it}$ and $y_i = \epsilon_{it}$. From the consumption function defined in equation (7) it follows that,

$$c_{ji} = \log(\beta_{ji}) + \log(1-T) + \epsilon_i \tag{8}$$

and hence,

$$U_j = \sum_{i=1}^{N} \beta_{ji}\epsilon_{it} - \sum_{i \neq j} \beta_{ji} r \tag{9}$$

where $r = \log(1-T)$.

Since the exchange rate in each region is able to respond to the region-specific productivity disturbance, there is full employment and hence output at the point of production is maximized. However, the existence of separate currencies involves a cost in transferring goods not produced in the region from one currency to another. This cost rises with β_{ji}, the proportion of good i in region j's consumption bundle.

A two country currency union

Consider now the equilibrium if two regions j and k chose to form a currency union. For simplicity it will be assumed that all other regions continue to float freely against each other. 1/ The exchange rate for the currency union is equal to the geometric average of the exchange rates of regions j and k in the free float analyzed above. Hence, $e_{jk} = (\epsilon_j+\epsilon_k)/2$.

The "normal" wage, ω, implies excess demand for labor in the region with the larger shock and too little demand for labor in the other region. Let j be the region with the larger shock and k be the region with the shortfall. Output and wages in the two regions are then,

$$\begin{aligned} y_j &= \epsilon_{jt}, \quad w_j = \log(\omega) + (\epsilon_{jt}-\epsilon_{kt})/2 \\ y_k &= \epsilon_{kt}-\alpha(\epsilon_{jt}-\epsilon_{kt})/(2(1-\alpha)), \quad w_i = \omega \end{aligned} \tag{10}$$

In region j, which has the excess demand for labor, the wage rises and labor remains fully employed. However, in region k the wage stays at the "normal" level of ω, and output falls below its full employment level. The equilibrium for the other regions remains unchanged.

The welfare effect of introducing the currency union can now be calculated from the difference between the utilities for the new equilibrium and those defined by equation 9. For regions j and k within the currency union and region and l outside of it,

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1/ The existence of other currency unions has no material implications for the analysis.

$$\Delta U_j = \beta_{jk}\tau - \beta_{jk}\alpha(\epsilon_j-\epsilon_k)/(2(1-\alpha))$$
$$\Delta U_k = \beta_{kj}\tau - \beta_{kk}\alpha(\epsilon_j-\epsilon_k)/(2(1-\alpha)) \qquad (11)$$
$$\Delta U_1 = -\beta_{1k}\alpha(\epsilon_j-\epsilon_k)/(2(1-\alpha)).$$

The first two equations, which show the impact on regions within the currency union, have a very similar format. The first term shows the gain to welfare from eliminating the transaction costs with the other region. This gain depends upon the size of these transactions costs (τ) and the importance in the home region's consumption of the good produced by the other region (β_{jk} or β_{kj}). The second term is the loss in welfare associated with the lower output in region k because of the lower flexibility of real wages caused by the currency union. This depends upon the importance of good k in regional consumption and upon the size of the difference between the two productivity shocks.

Within the currency union each region has a 50 percent chance of facing excess demand for labor and a 50 percent change of facing a shortage of demand for labor. The expected value of the change in welfare for a region in the currency union is therefore,

$$\begin{aligned} E(\Delta U_j) &= \beta_{jk}\tau - \alpha\beta_{jj}E(\epsilon_j-\epsilon_k|\epsilon_j<\epsilon_k)P(\epsilon_j<\epsilon_k) - \alpha\beta_{jk}E(\epsilon_k-\epsilon_j|\epsilon_j>\epsilon_k)P(\epsilon_j>\epsilon_k) \\ &= \beta_{jk}\tau - \alpha\beta_{jj}2\phi(0)\sqrt{\sigma_j^2-2\sigma_{jk}+\sigma_k^2}\,\frac{1}{2} - \alpha\beta_{jk}2\phi(0)\sqrt{\sigma_j^2-2\sigma_{jk}+\sigma_{kk}}\,\frac{1}{2} \qquad (12) \\ &= \beta_{jk}\tau - \alpha(\beta_{jj}+\beta_{jk})\,\phi(0)\sqrt{\sigma_j^2-2\sigma_{jk}+\sigma_k^2} \end{aligned}$$

where $\phi(.)$ is the density function for a standard normal variate with mean 0 and standard deviation 1, σ_j^2 is the variance of the productivity

disturbance in region j, and σ_{jk} is the covariance between the productivity disturbances in regions j and k. 1/

Equation (12) illustrates the gains and losses involved in joining a currency union. The first term shows the gain in welfare from the lower transactions costs associated with trade with the other member of the union. This depends upon the degree to which home consumers desire the goods from the other region (β_{jk}). The expected costs of joining a currency union depends upon the importance in consumption of all goods produced in the currency union ($\beta_{jj}+\beta_{jk}$) and on the variance of the difference between the underlying disturbances. This variance in turn depends upon both the sizes of the underlying disturbances and the correlation between these disturbances, i.e., the likely size of asymmetric disturbances.

The analysis to this point has focused on the impact on the members of the currency union. However, equation (11) also shows that the impact of a currency union on other regions is unambiguously negative. In expected value terms the change in utility is,

$$E(\Delta U_1) = -(\beta_{1j}+\beta_{1k})\,\phi(0)\sqrt{\sigma_j^2-2\sigma_{jk}+\sigma_k^2} \qquad (13)$$

The currency union reduces welfare for all regions outside of the union, with the largest reductions occurring in those regions whose consumption is most closely connected with the currency union. The intuition behind this result is straightforward. The gains from lower transaction costs are limited to regions within the currency union. However, the losses from a

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1/ The expected value of a standard $N(0,\sigma^2)$ normal variate ϵ given that $\epsilon > X$ is $\sigma\,\phi(X)/\Phi(X)$ where $\phi(.)$ and $\Phi(.)$ are the density function and the cumulative density function of a standard N(0,1) normal distribution.

currency union, in the form of lower output caused by lower real wage flexibility, affect all regions through their trade patterns. Hence, while the welfare gains are limited to those regions within the currency union, the welfare losses affect all regions and depend, amongst other things, upon the suitability of the currency union itself in terms of the size and correlation of the underlying productivity disturbances.

It should be recognized that the conclusion that a currency union automatically reduces welfare outside of the union depends to some extent upon the structure of the model. One can certainly think of ways in which a currency union could raise welfare outside of the union. For example, a currency union could increase the level of potential output within the union through the operation of economies of scale or the diversion of resources from transactions services to the production of goods, thereby raising world output and hence consumption. In addition, a currency union could reduce transaction costs outside of the union through lower costs of entrepot trade and fewer units of account. To the extent that these factors are important, the gains from them should be set against the welfare losses highlighted above.

Currency unions with more than two regions

Now consider a currency union made up of k regions, $i = 1$ to k. Compared to a situation when all regions have floating exchange rates with each other, the gain for region i comes from the lowering of transaction costs for products produced by other regions in the union. The losses come from expected output losses within the currency union caused by the rigidity in wages combined with the common exchange rate, which is equal to the mean

of all of the productivity disturbances in the currency union, $\bar{\epsilon}_k$. It is easy to show that region i has full employment when its productivity shock, ϵ_i, is above the average for the currency union as a whole, and output losses when its productivity disturbance is below this average. The expected loss in output for any region is therefore,

$$\begin{aligned} E(\Delta y_i) &= -\alpha E(\epsilon_i - \bar{\epsilon}_k \mid \epsilon_i < \bar{\epsilon}_k) P(\epsilon_i < \bar{\epsilon}_k) \\ &= -\alpha \phi(0) \sqrt{\sigma_i^2 - 2\sigma_{i\bar{\epsilon}_k} + \sigma^2_{\bar{\epsilon}_k}} \end{aligned} \tag{14}$$

Since each region has this expected loss in output, the change in expected utility from forming a currency union made up of regions k on a region i within the currency union and region l outside of it is,

$$\begin{aligned} E(\Delta U_i) &= \sum_{k \neq i} \beta_{ik} \tau - \sum_k \beta_{ik} \phi(0) \sqrt{\sigma_i^2 - 2\sigma_{i\bar{\epsilon}_k} + \sigma^2_{\bar{\epsilon}_k}} \\ E(\Delta U_l) &= -\sum_k \beta_{lk} \phi(0) \sqrt{\sigma_k^2 - 2\sigma_{k\bar{\epsilon}_k} + \sigma^2_{\bar{\epsilon}_k}} \end{aligned} \tag{15}$$

where $\bar{\epsilon}_k$ is the mean of the disturbances in the currency union.

This is a multi-region version of equations (12) and (13). As in equation (12), the gains for regions within the currency union depend upon the importance of goods from other parts of the currency union in consumption, while the losses depend upon the importance of all currency union products in consumption and upon the expected size of the underlying asymmetric disturbances. As in equation (13), regions outside of the currency union lose unambiguously.

Equation (15) shows the change in utility when a number of regions decide to move from independent currencies to a currency union in a bloc. The same approach can be used to see the marginal change in utility to a

region if it joins an existing currency union. Letting j represent the entering region and k represent the regions already within the existing union, the expected change in utility for the entrant is,

$$E(\Delta U_j) = \sum_k \beta_{jk} r - \beta_{jj}\,\phi(0)\left[\overline{\sigma_j^2 - 2\sigma_j \bar{\epsilon}_{k+j} + \sigma^2_{\bar{\epsilon}_{j+k}}}\right] - \sum_k \beta_{jk}\phi(0)\left[\left[\overline{\sigma_k^2 - \sigma_k \bar{\epsilon}_{k+j} + \sigma_{\bar{\epsilon}_{k+j}}}\right] - \left[\overline{\sigma_k^2 - \sigma_i \bar{\epsilon}_k + \sigma^2_{\bar{\epsilon}_k}}\right]\right] \tag{16}$$

where $\bar{\epsilon}_{k+j}$ represents the average of the disturbances including the new member and $\bar{\epsilon}_k$ bar refers to the averages of the disturbances excluding the new member.

The first term in the equation, which shows the gain from lower transaction costs with the other members of the union, is the same as in equation (15). However, the losses from joining the union, represented by the second and third terms in the expression, are somewhat different from the earlier case. The second term shows the loss in expected welfare caused by asymmetric disturbances in the region joining the union. It has the same form as the second term in equation (15), but is limited to the joining region since the other regions are already within a currency union, and hence are already affected by the nominal rigidity. The third term represents the loss in utility caused by lower output in the regions which are already within the currency union. These losses come from the fact that a new member, with different underlying disturbances, has joined the union, thereby reducing the expected correlation between the individual

disturbances experienced by specific regions and the aggregate disturbance in the entire union. 1/

Comparing equations (15) and (16), it can be seen that the change in welfare from joining an already existing currency union is always greater than that from forming a new currency union made up of the same regions. This is because many of the output costs implied from forming a new currency union from scratch are already present for a region which is outside of an already existing currency union. Since these welfare losses are already present, as reflected in the reduction in utility for regions outside of the currency union shown in equations (13) and (15), they do not enter into the calculation of whether to join an existing union or not.

As a result, it is possible that a region which would ideally prefer that all regions have separate currencies may still have an incentive to join a currency union which other regions intend to form. This is because the region will still be negatively affected by the losses in output in other regions within the currency union caused by the common currency even if the region does not join the currency union itself. Since this part of the loss in welfare is out of the control of the region, it has no effect on its marginal decision to join a currency union that is being formed.

While the incentive to join an already existing union is always greater that the incentive to form a new currency union, the incentive to admit a

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1/ For the union as a whole the expected output must fall since the addition of a new region increases the variance of total disturbances within the currency union. Individual regions within the union could, however, have a rise in expected output if their output disturbances are highly correlated with those of the region which is joining the union.

new member to a union is not altered. The change in utility for a region i which is already within a currency union from region j joining the union is,

$$E(\Delta U_i) = \beta_{ij} r - \beta_{ij}\,\phi(0)\sqrt{\sigma_j^2 - 2\sigma_j\bar{\epsilon}_{k+j} + \sigma^2_{\bar{\epsilon}_{k+j}}} - \sum_k \beta_{ik}\phi(0)\left(\sqrt{\sigma_k^2 - \sigma_k\bar{\epsilon}_{k+j} + \sigma^2_{\bar{\epsilon}_{k+j}}} - \sqrt{\sigma_k^2 - \sigma_k\bar{\epsilon}_k + \sigma^2_{\bar{\epsilon}_k}}\right). \tag{17}$$

The losses in utility in the second and third terms of the expression are very similar to the results for the entrant, shown in equation (16). The expected utility of regions within the existing union are reduced both by lower expected output in the entrant region and from the diminution of the correlation between individual regional disturbances with the mean disturbance within the currency union. Unlike equation (16), however, the gains from admitting the new region for existing members of the union are limited to lower transaction costs on trade with the new entrant. Hence, while the entrant reduces transaction costs with all of the existing regions in the union, the existing regions only lower transaction costs with the new entrant. In general, therefore, small outlying regions with close ties to an existing currency union will have a significant incentive to join that union, while existing members of the union will have no new incentives to let them in. This illustrates the importance of external openness in the benefits of a currency union, a point emphasized in McKinnon (1963) and Melitz (1991, 1993).

A new entrant into an already existing currency union will also lower utility for regions outside of the union. The loss in expected utility is not reported since it is a simple variation on the losses in utility given in equations (16) and (17).

Labor mobility

To this point the analysis has assumed that labor is not mobile between regions. In his original article on optimum currency areas Mundell argued that labor mobility was a key criteria in the choice of a currency union. The reason for this can be clearly seen in the present analysis. The losses from forming a currency union are caused by the nominal rigidity in wages. However, if labor is mobile within the currency union then this will partially nullify the inefficiencies caused by the wage rigidity.

To analyze this issue the implicit assumption that labor is immobile between regions within the currency union must be relaxed. Ideally, a fully specified process describing labor mobility between regions should be developed. Presumably this incentive to move would be based on the difference in current and expected future income and the costs of moving. For the purposes at hand a simpler mechanism will be outlined.

Assume that all labor which is offered employment within a region stays in that region. If labor is not employed it can move to another region in the currency union. However, there are costs to this movement. As a result, the rise in effective labor in the region receiving the labor is only a proportion δ of labor which is not employed in the depressed region. 1/ Hence, if in the initial equilibrium with no labor mobility employment in region j was 1 and in region k was (1-X), the new equilibrium involves effective employment levels of $(1+\delta X)$ and (1-X), respectively.

If X is small then log(1+X) can be approximated by X. For the two-region currency union the resulting equilibrium is,

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1/ The initial model can be thought of as having $\delta=0$.

$$y_j = \epsilon_j + \alpha\delta(\epsilon_j-\epsilon_k)/(2(1-\alpha)), \quad w_i = \log(\omega) + (1-\delta)(\epsilon_j-\epsilon_k)/2$$
$$y_k = \epsilon_k - \alpha(\epsilon_j-\epsilon_k)/(2(1-\alpha)), \quad w_k = \log(\omega). \tag{18}$$

The equilibrium for region k, where labor is not fully employed, is the same since the level of employment is unchanged. However, output (and employment) in region j, the region with the excess demand for labor, is now higher since labor has moved to this region from the depressed region. 1/ This flow of labor reduces the fall in aggregate output for the monetary union, hence lowering the costs of monetary union for all.

This can be seen in welfare calculations. The expected changes in utility for a region j within the currency union and region 1 outside it become,

$$E(\Delta U_j) = \beta_{jk}\tau - \alpha(\beta_{jj}+\beta_{jk})(1-\delta)\phi(0)\sqrt{\sigma_j^2-2\sigma_{jk}+\sigma_k^2}$$
$$E(\Delta U_1) = -\alpha(\beta_{1j}+\beta_{1k})(1-\delta)\phi(0)\sqrt{\sigma_j^2-2\sigma_{jk}+\sigma_k^2} \tag{19}$$

The gains from the monetary union remain unchanged. However, the losses in utility caused by lower output are reduced by a factor of $(1-\delta)$. Hence, labor mobility lowers the costs associated with a currency union both inside and outside of the union. Indeed, in the extreme case of perfect labor mobility (δ=1), there are no output costs associated with forming a currency union.

These results easily generalize to the case of a currency union with n regions. If proportion δ of the labor in regions with low employment

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1/ The approximation $\log(1+X) = X$ slightly underestimates the rise in aggregate output since it fails to account for the fact that labor is moving from a low productivity region to a high productivity one.

relocate to regions with excess demand for labor, the losses in output and welfare from the nominal rigidity also fall by proportion δ.

IV. Reinterpreting the Criteria for Choosing a Currency Union

This model can be used to reinterpret the various criteria set out in the literature on optimum currency areas: the correlation of the underlying disturbances; the level of labor mobility; the openness of the economy; and the level of diversification of the economy. As will be seen, all of these criteria turn out to be important in this model.

As discussed earlier, the size and correlation of the underlying disturbances is clearly important in this model for the choice of a currency union. This can be seen clearly from the expected welfare calculations, and justifies the empirical literature which focuses on the nature and correlation of underlying disturbances within a region. 1/ Labor mobility has also been shown to be important, again supporting the empirical work on this form of adjustment. 2/

The level of openness of the economy to regions outside of the currency union matters for both the gains and losses produced by a currency union. The gains from forming a currency union depend directly upon the level of demand for the products of other proposed regions. The losses depend upon the demand for the products of *all* regions in the union including the home region. Hence, assuming the same structure of underlying disturbances, a

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1/ See Cohen and Wyplosz (1989), Weber (1990) and Bayoumi and Eichengreen (1993, 1994).

2/ Blanchard and Katz (1991) and Eichengreen (1993).

region will generally prefer to join in a currency union with another region whose products it uses more rather than less. 1/

Finally, industrial diversification is also relevant to the choice of a currency union. Consider a group of regions which have joined in a currency union. The regions are highly diversified if the underlying disturbances are not highly correlated. Since the common exchange rate is equal to the mean of these disturbances, it is clear that the more diversified the group of regions, the lower the variance of the external exchange rate. This, in turn, will generally lower the costs of expanding the currency union, since entrants will face fewer aggregate disturbances from the rest of the union.

V. Conclusions

This paper sets out a formal model of optimum currency areas. The objective was to combine many of the insights from the earlier, less technical, literature in a well specified model with a stronger basis in microeconomic theory. The result is a flexible framework which incorporates such fundamental factors as the size of the underlying disturbances, the correlation between the disturbances in different regions, the costs of transactions between different currencies, the level of factor mobility across regions, and interrelationship of demand between regions. As such it embodies the criteria for optimum currency areas suggested in the original papers by Mundell, McKinnon, and Kenen.

1/ This mechanism, however, is rather different from the one proposed by McKinnon.

The framework provides some valuable insights on the welfare effects of currency unions. The most interesting insight is that, while a currency union can raise welfare of the regions within the union, it unambiguously lowers welfare for regions outside of the union. This is because the gains from the union, in the form of lower costs of transacting business, are limited to the members of the union, while the losses from the union, in the form of lower output due to the interaction between the common exchange rate and the nominal rigidity, affect everybody. Hence, regions outside of the union partake in the costs of the union but not in the benefits. Clearly, one can think of circumstances outside of the scope of the model in which a currency union would not lower welfare outside of its boundaries. For example, if aggregate output rose within the union due to economies of scale or more efficient financial intermediation. However, the result is a useful reminder that the impact of a currency union need not be benign to those left out of its sway.

Another insight is that the incentives for a region to join a currency union are different from the incentives to admit a region into a union. The entrant gains from lower transactions costs on trade with the entire existing union, while the incumbent regions only gain on their trade with the potential entrant. As a result, a small region will always have a greater incentive to join a union than the union will have an incentive to admit the new member. A corollary of this is that, even if a country would prefer a free float across all regions, it may still have an incentive to join a currency union with other regions if it is going to be formed. This is because most of the welfare losses from the nascent union will occur

whether or not the region decides to join. This set of incentives may explain why some countries in the European Union who are not particularly convinced of the merits of European Monetary Union (EMU) are also worried about being relegated to the second division of a two speed EMU.

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