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DYNAMIC SCALE ECONOMIES, SPECIALIZATION, AND THE COST OF THE SINGLE CURRENCY*

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Introduction

Much of the discussion on the consequences of the introduction of the single currency in Europe has centered upon the implications for monetary policy management and the behavior of the European Central Bank. Very little attention has been devoted to the implications for the real sector following the introduction of the euro, with the exception of the benefits deriving from the elimination of transaction costs and currency risk within the monetary union. Little or no attention has been devoted, in particular, to the effects of the single currency on the dynamics of the specialization structure and their consequence for the foreign trade of countries belonging to monetary union. This paper investigates these two latter aspects.

Two different issues are considered. The first one deals with the costs in terms of specialization structure and exports once the exchange rate instrument is given up. The second relates to the role of labor market adjustment in a monetary union. Both issues will be analyzed by a ricardian model of trade with a continuum of goods[1] (Dornbusch, Fisher, Samuelson, 1977; DFS in what follows). This model is particularly useful for an analysis such as the present one which concentrates on the implications of monetary union for the structure of comparative advantage. The DFS model will be partially modified so as to introduce a first order relationship between production performance and innovation efforts. Subsequently a production-productivity relationship will be introduced so as to take into account a cumulative causation mechanism along Kaldor-Myrdal lines, as suggested in Krugman (1987). Dynamic scale effects deriving from such mechanism are indeed at the center of the discussion, both theoretical and policy-oriented, on the effects of monetary union in Europe. The third part of the paper discusses the consequences of some parametric

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[1]Several other authors have used the DFS model to investigate changes in the structure of comparative advantage. See Wilson (1980), Collins (1985),and Krugman (1987). Cimoli (1995) and Murat and Pigliaru (1995) -both in Pugno and Segnana (1995) - have used the DFS model in a technology -gap structuralist framework.

changes on the structure of comparative advantage; more precisely we will discuss whether and to what extent giving up the exchange rate entails a cost in terms of comparative advantage changes, to what extent labor market policies can be effective in reverting these changes and what is their relationship with innovation policies.

A ricardian model with a continuum of goods

The model includes two countries, the home country -H- and the foreign country -F- (variables related to F will be denoted by an asterisk). Each of the two countries produces some of the n goods with one factor of production, labor l. To exemplify good x_i is produced in country H according to the following production function

$$x_i = a_i \cdot l_i \cdot r_i \qquad i \in [0, n] \tag{1}$$

where a indicates constant labor productivity and r is the exogenous innovation effort[2]. Production increases linearly with r and l[3]. Along similar lines product j will be produced in country F. All products are tradables.

The i-th (or the j-th) good belongs to a continuum of goods. Hence we can classify the goods produced in the two countries according to their relative productivities, $A(z)=a(z)/a^*(z)$ with index $z\in[0,1]$ and the function $A'(z)<0$. It follows that $A(z)$ is, by construction, a continuously decreasing function.

If we neglect transport costs, trade policy effects, and assume perfect competition, the production of a good denoted by index z in country H or in country F will depend only on relative efficiency in each country, i.e. if we indicate $w = w/(w^* \times e)$ the ratio of the unitary wage in country H and of the unitary wage in country F, measured, given the exchange rate e, in country's H currency (in the rest of the paper w will be referred to as the real exchange rate), and if we indicate with $r = r/r^*$ the ratio between innovation efforts [4] in the two countries, good z will be produced efficiently in country H if

$$a(z) \geq a(z)^* \cdot \frac{w}{r}. \tag{2}$$

[2]To keep the model as simple as possible innovation efforts will be considered as exogenous. For an approach where innovation is endogenous in a competitiveness and growth model and for empirical evidence thereof see Padoan (1998).

[3]A different formulation of the production function is $x_i = a_i(r_i) \cdot l_i$ where labor productivity is a direct function of the innovation effort. Our formulation which bears the same meaning, allows to consider the initial value of a from changes determined by r.

[4]Which can be expressed, for example, in terms of relative patent production .

International distribution of production and hence the position of good $\bar{z}$, that discriminates between comparative advantages and disadvantages, is a function of the real exchange rate w and of the relative innovation effort r [5]. Equation (2) can thus be rewritten as follows

$$A(\bar{z}, r) = \overline{w} \tag{3}$$

The equilibrium value of w (associated with $\bar{z}$ and r) is, in turn, a function of demand conditions. As we are interested in the structure of comparative advantage and not on specific goods we assume identical tastes in the two countries as well as uniform homothetic demand functions. This implies that consumption expenditure is uniformly distributed across the n goods. In a continuum the fraction of income spent, in both countries, on goods in which country H has a comparative advantage is

$$q(\bar{z}) = \int_0^{\bar{z}} b(z)\, dz \qquad q \in [0,1] \tag{4}$$

where $b(z)=b^*(z)$ is the constant fraction of income spent on a given good z.

The budget constraint which results from the above specification can be expressed in terms of the trade balance by assuming that the value of H's imports must be equal to the value of its exports, given the nominal exchange rate e

$$[1-\theta(\bar{z})]\cdot w \cdot l = \theta(\bar{z})\cdot w^* \cdot e \cdot l^* . \tag{5}$$

Equation (3) and equation (5) may be expressed as

$$\omega = A(z, \rho) \tag{3'}$$

$$\omega = \frac{\theta(\bar{z})}{[1-\theta(\bar{z})]}\cdot\frac{l^*}{l} = B\left(z, \frac{l^*}{l}\right) \tag{5'}$$

Equations (3') and (5') describe the basic DFS model whose solution – which does not necessarily imply full employment - determines the relative wage and the structure of comparative advantage for each country, as shown in figure 1.

Figure 1. Comparative advantages in the DFS model

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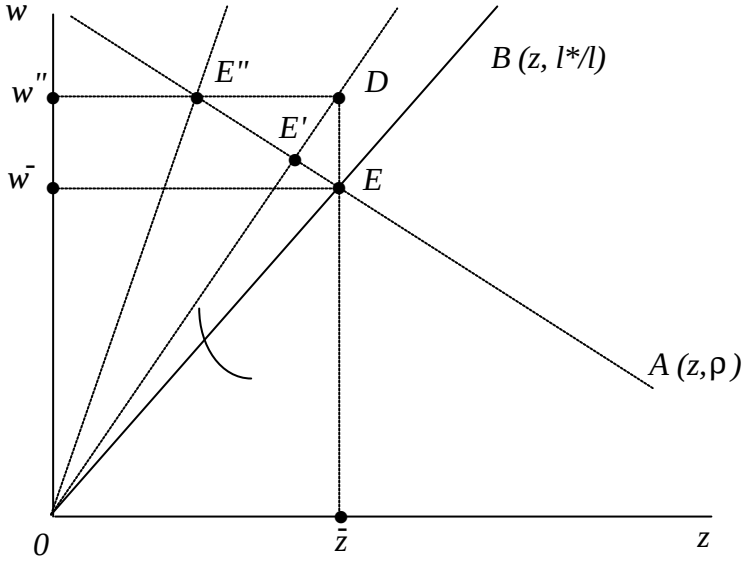
[5]Cost minimization implies that the price of the good produced in H is $p(z) = \dfrac{w}{a(z)\cdot r}$ hence condition (2) is equivalent to the relation between prices in H and F, $p(z) \le p^*(z)\cdot e$.



The *A* schedule separates the *w-z* space into two zones of relative efficiency; the area to the left of schedule *A* indicates points of lower relative efficiency for country H, the area to the right of schedule *A* indicate points of relative higher efficiency. Put it differently, the *A* schedule is the relative technological frontier. For example, a uniform improvement of production techniques in country H following an increase in r, would lead, for a given real exchange rate, to a shift of schedule *A* to the right.

The *B* schedule divides the *w-z* space between a trade deficit zone - points to the left of schedule B- and a surplus zone -points to the right of schedule *B*.

The equilibrium point *E*, which is unique given the structure of demand, as well as stable, corresponding to $\bar{w}$ and $\bar{z}$, identifies the structure of comparative advantage in the two countries. Country H will produce and export goods included in interval 0- $\bar{z}$, country F will produce and export goods included in interval $\bar{z}$ -1.

Let us now look at the first of the two issues we want to explore in this paper, the role of the exchange rate in the determination of the structure of comparative advantage and what is the cost of giving it up.

We can start by looking at figure 1 again. Suppose that the relative wage w increases as a consequence of an increase in w, the domestic wage. For a given specialization structure $\bar{z}$ the economy would move to point *D* in the trade deficit area. If the nominal exchange rate is free to adjust it will rise up to a level that brings the value of *w* back to its initial equilibrium level. I.e. the role of the exchange rate is to keep the balance of payments and the structure of specialization in equilibrium. Suppose now that, because country H and country F decide to set up a monetary union the exchange rate is irrevocably fixed and set to one. In such a case, a different adjustment mechanism would then be set in motion, involving two different variables. In the first place -given equation (3') – the increase in w will increase the cost of production, the number of productions located in H would then decrease, i.e there would be a movement to the left along schedule *A*. In the second place, but indeed as a simultaneous process, the amount of labor employed in H, *l*, would decrease because of the smaller number of production located in H. In addition if we

assume an inverse relationship between employment and wages, the domestic wage would decrease because of the lower demand for labor. Symmetrically, the number of products, the amount of employment *l**, and the wage level *w** would increase in F. The increase in relative employment *l*/l* would increase the slope of schedule *B* until the new equilibrium point *E'* is reached. On the other hand, if wages are set institutionally the mechanism at work would be the same (unless the movement in wages) and the equilibrium point would be *E"*, corresponding to an even lower level of $\bar{z}$ ($\bar{z}$").

The indication is thus straightforward and not surprising. If the nominal exchange rate is fixed a disequilibrium process, induced by a real appreciation following an increase in domestic wages, implies that adjustment is obtained in the labor market through a change in both employment and the wage level. The domestic economy will see lower employment with a higher wage rate for the smaller number of employed workers. What is new with respect to the standard analysis is that this process also implies a change in the structure of comparative advantage through deindustrialization.

Dynamic scale economies

We now assume, along the kaldorian tradition (De Benedictis 1998) and the contributions that have extended the DFS model (Krugman 1987, Cimoli 1995) to the case of increasing returns, that production is characterized by cumulative causation. This implies that good x_i is produced in country H according to the following production function

$$x_i(t) = a_i(t) \cdot l_i \cdot r_i(t) \qquad i \in [0, n] \tag{1'}$$

where, contrary to the DFS model, production depends also on the constant rate of growth of the innovation effort and of productivity changes related to the stock of cumulated production, at time τ:

$$a_i(t) = k_i(t)^e = \left[\int_{t=0}^{t} \left[x_i(t) + d \cdot x_i^*(t) \right] \right]^e . \tag{6}$$

In Equation (6) labor productivity in country H in the *i*-th good depends, in a given point in time, both on the stock of cumulated production (learning by doing) and by the international diffusion of knowledge, itself related to the stock of cumulated production of the *i*-th good in country F. The degree of international diffusion is identified by parameter δ. Equation (1') implies dynamic scale economies.

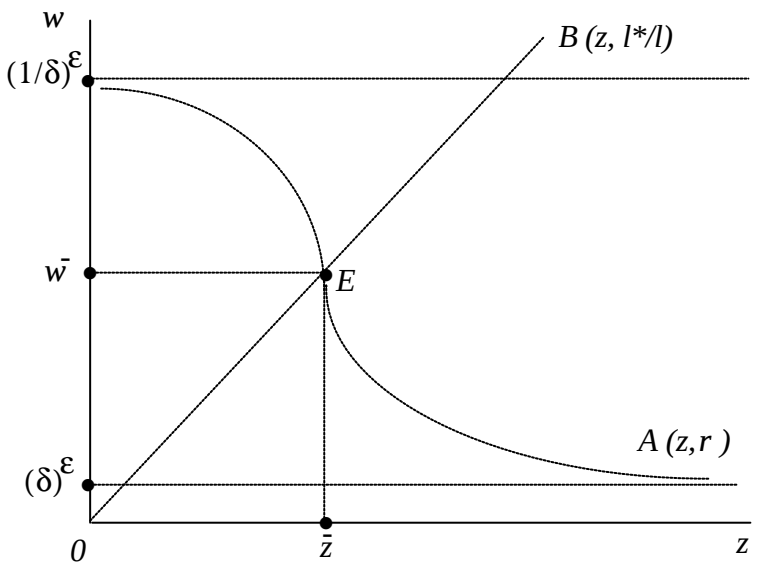
The new system is therefore

$$w = A(z, r) = \left[\frac{k}{k^*}\right]^e \tag{3''}$$

$$w = \frac{q(\bar{z})}{[1-q(\bar{z})]} \cdot \frac{l^*}{l} = B\left(z, \frac{l^*}{l}\right). \tag{5''}$$

As shown in Krugman (1987), the steady state solution for k/k^* must fall between d and $1/d$, which implies that the dynamic path of relative productivity and of the relative equilibrium wage, given (3”), must fall between δ^ε and $(1/\delta)^\varepsilon$, as shown in figure 2.

Figure 2. Comparative advantage in the short run



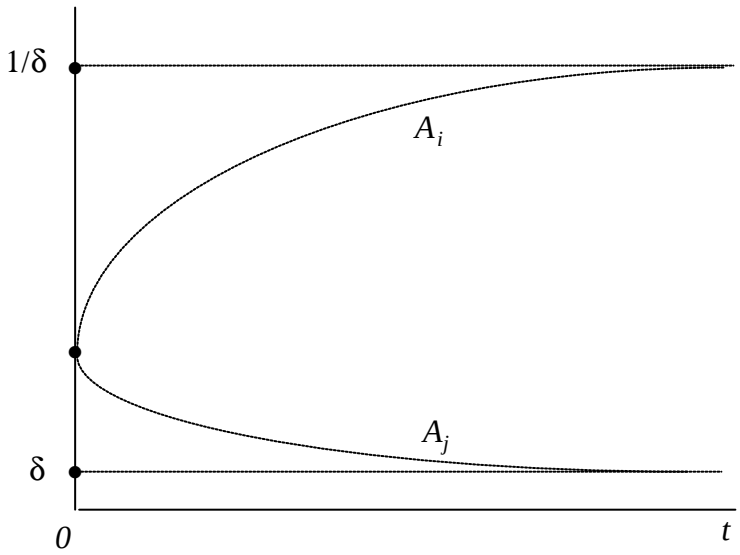
The case described in figure 2 is not a final equilibrium however. The dynamic of productivity is driven by Equation (6) and crucially depends, for any given good, on the fact that this good belongs to the set of goods that are produced in H and hence exported or, alternatively to the set of those goods that could potentially be produced in H but that are imported. To restate the point differently the ricardian features of the model imply that country H produces and exports only those good which display a relative higher efficiency (i.e. goods included in the 0-$\bar{z}$ interval); symmetrically, country F produces and exports those goods for which it enjoys higher relative efficiency and which are imported by country H. It follows that, both in country H and in country F, the relative productivity of specific goods will differ between exported and import substitute goods. For example, in country H labor productivity in the production of good i , which is produced and exported, will differ from the (potential) labor productivity of good j which is imported, according to the following expressions:

$$a_i(t) = k_i(t)^e = \left[\int_{t=0}^{t} \left[x_i(t) \right] \right]^e$$

$$a_j(t) = k_j(t)^e = \left[\int_{t=0}^{t} \left[d \cdot x_j^*(t) \right] \right]^e .$$

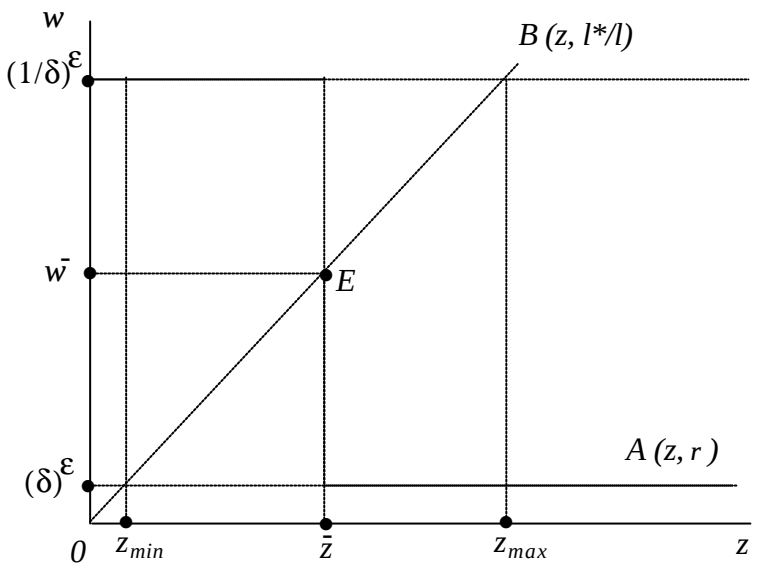
Figure 3 shows the evolution over time of the relative productivity between exported goods and import substitutes in country H.

Figure 3 Relative productivity of imports and exports in country H



It is clear that, over time, the initial structure of comparative advantage is reinforced as the technology gap between exported and imported goods increases. Country H rises its efficiency in the production of goods included in the 0-$\bar{z}$ interval while country F rises its efficiency in the production of goods included in the $\bar{z}$-1 interval. In other words, the dynamics of productivity locks in a country in its initial comparative advantage, as shown in figure 4.

Figure 4. Structural comparative advantages



The broken line *A* shows the behavior of relative productivity with respect to the continuum of goods, and together with the balance of payments constraint, identifies the area of possible changes in the real exchange rate and in the structure of comparative advantage. The cumulative causation process reinforces the differences between country H and country F.

The role of international knowledge diffusion determines the extension of the vertical segment of schedule *A*. A lower amount of diffusion implies a greater distance between δ and 1/δ. If diffusion increases the extension of vertical segment tends to zero and the A schedule becomes horizontal.[6]

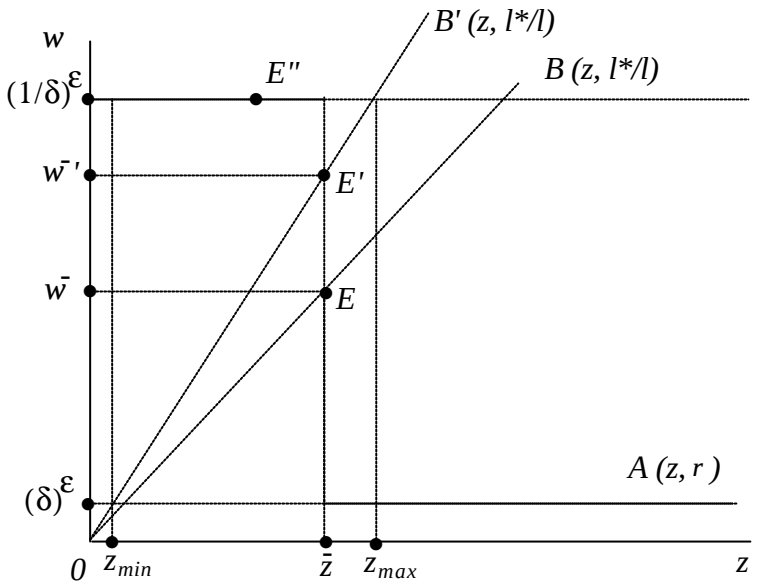
Dynamic scale economies introduce major changes in the analysis of the exchange rate on comparative advantage. This is discussed in the next paragraph.

Dynamic scale economies and the exchange rate

In the DFS model changes in the real exchange rate lead to changes in the structure of comparative advantage. The introduction of dynamic scale economies partially rules out this effect. The vertical segment in schedule *A* implies that only substantial changes in the real exchange rate lead to changes in the structure of comparative advantages. Let us look at figure 5.

Figure 5. Structural comparative advantages and dynamic scale economies.

[6]If δ=1 there no distinction over time between a_i and a_j. The dynamic of productivity described in figure 3 would be an horizontal line with an intercept equal to one and there would be no benefit from international trade.



As we seen previously, a change in the real exchange rate (and in relative employment) leads to a shift in the slope of schedule *B* leading to a new equilibrium point E', now associated to a higher level of w but to the same value of $\bar{z}$. The productivity gap between H and F is so large about $\bar{z}$ to rule out changes in the structure of specialization. Such a change would require a substantial variation in the real exchange rate to move the equilibrium point to E". This shows that in a monetary union, where changes in the relative wage cannot be compensated by a change in the nominal exchange rate, the same changes are not excessively costly for domestic specialization. This does not imply, however, that a monetary union rules out the possibility of changing, and possibly improving, domestic comparative advantages. This requires looking at the role of other polices instruments.

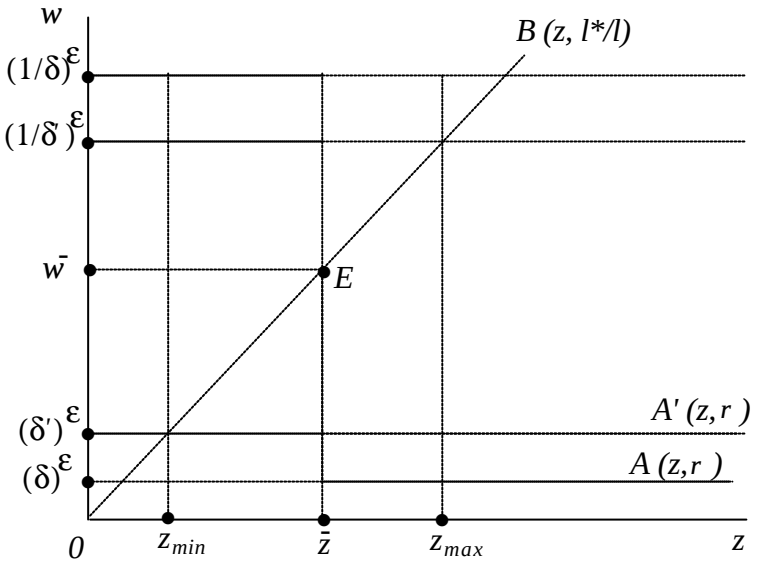
Policy options in a monetary union. Innovations efforts, technology diffusion, and employment policies

Much of the debate about the functioning of the euro has concentrated on the need to increase labor market flexibility in Europe once the exchange rate is eliminated. In what follows we will argue that labor market policies are a necessary, but a not sufficient, condition to ensure an efficient performance of a national economy in a monetary union. Such policies need to be complemented by other policies targeted at enhancing innovation efforts.

As we have seen above, if dynamic scale economies are present, changes in the structure of comparative advantage can take place only if the slope of the *B* schedule changes substantially and/or if the *A* schedule shifts.

The distinction between movements in the two schedules allows us to consider the consequences of different policy actions. Let us consider the consequences of an increase in the degree of international knowledge diffusion as shown in figure 6.

Figure 6. Dynamic comparative advantages and an increase in the diffusion of knowledge

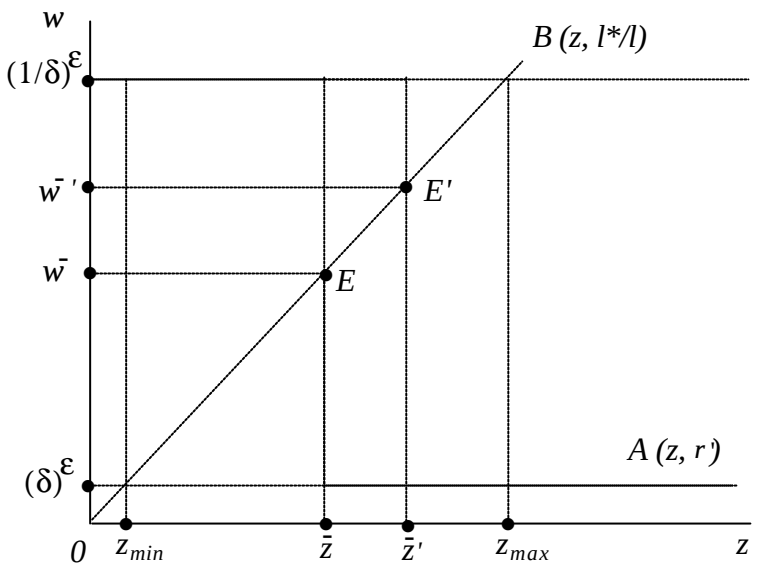


An increase in d produces a decrease in the width of the vertical segment of schedule *A*, hence the productivity gap between countries F and H decreases. This does not influence the comparative advantage equilibrium, i.e the value of $\bar{z}$. In such a case policies that increase the intensity of knowledge diffusion in a monetary union[7] do not produce any effect on the distribution of comparative advantage. However, we will reconsider this case later.

Different results can be obtained if the innovation effort is strengthened though innovation policies. To the extent that the result of such policies is an increase in r the *A* schedule shifts to the right as shown in figure 7. As a consequence a new equilibrium point E' is reached and the number of goods produced efficiently in country H increases. This implies that demand for domestic goods increases putting an upward pressure on domestic wages. Equilibrium point E' is therefore associated with a higher value of ω and of $\bar{z}$. We find a confirmation of the so called "Kaldor paradox" (Kaldor 1978): higher wages are consistent with a larger specialization spectrum. This also shows that policies that strengthen the innovative effort are indeed effective in improving the pattern of specialization.

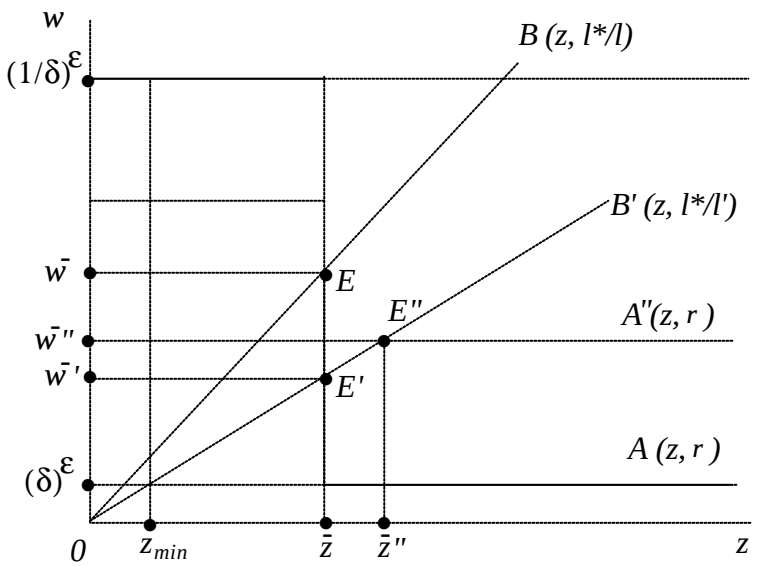
Figure 7. Comparative advantage and an increase of innovation effort

[7] . Such as investment in transnational networks, infrastructure etc.



Let us now consider a second issue : the effects of "active labor market policies" on specialization and employment. One example of such policies would be the a wage policy (a simple form of "income policy") targeted at obtaining higher employment levels in exchange for a lower (relative) wage. A reduction in *w* associated to an increase in *l* would decrease the slope of schedule B, leading a new equilibrium point E' as shown in figure 8.

Figure 8. Comparative advantage, wages, and employment



What is important to note is that such a labor policy would increase employment levels but it would not improve the structure of specialization unless the drop in *w* is substantial. Different results are obtained if active labor policies are accompanied by appropriate technology policies. The new equilibrium point E" is associated to both higher employment and to an expanded range of comparative advantage. This result

is quite relevant for the operation of a monetary union. In the case of Europe, the joint pressure of monetary union and the single market is likely to increase the intensity of knowledge diffusion[8]. In such a context active wage and employment policies, alongside with innovation policies will represent an effective policy strategy to improve a country's specialization structure.

Conclusions

Our main results can be summarized as follows. Changes in the real exchange rate in a monetary union do have an effect on specialization if no dynamic scale effects are present. In such a case the loss of the nominal exchange rate as an adjustment variable is relevant as real appreciation implies a narrowing of the range of national comparative advantage (deindustrialization). If dynamic scale economies are present, real appreciation, to the extent that it is not extremely large, does not necessarily lead to deindustrialization, but it does lead to lower employment levels. The analysis confirms the crucial role of labor markets in the adjustment process once the exchange rate is given up. However, active labor market policies which lead to lower relative wages increase the employment level while leaving the structure of comparative advantage unchanged. A widening of the range of specialization can be obtained only if active innovation policies are implemented. This suggests that labor market polices and innovation policies should be seen as complements in designing policy strategies in a monetary union. Finally, as long as the intensity of international knowledge diffusion is limited, changes in the structure of specialization are unlikely. However, in the European case, as the process of real and monetary integration further deepen, the intensity of knowledge diffusion is likely to increase, thus making active labor market and innovation policies more effective in changing the structure of comparative advantage.

References

Cimoli Mario (1995), "Tecnologia, specializzazione e crescita: un approccio strutturalista", in Pugno Maurizio, Maria Luigia Segnana (ed.), *Commercio internazionale e crescita economica*, NIS, Roma, p.249-291.

Collins Susan M. (1985), "Technical Progress in a Three-Country Ricardian Model with a Continuum of Goods", *Journal of International Economics*, 19, 171-179.

De Benedictis Luca (1998), "Cumulative Causation, Harrod's Trade Multiplier, and Kaldor Paradox: The Foundations of Post-Keynesian Theory of Growth Differentials", in Giorgio Rampa, Luciano Stella and A.P. Thirlwall (ed.),

[8]Some evidence of the European dimension of knowledge diffusion as well as of the role of technology accumulation in affecting competitiveness and growth is offered in Padoan (1997).

Economic Dynamics, Trade and Growth. Essays on Harrodian Themes, MacMillan, London.

Dornbusch Rudiger, Stanley Fischer, Paul A. Samuelson (1977), "Comparative Advantage, Trade, and Payments in a Ricardian Model with a Continuum of Goods", *American Economic Review*, Dic, 823-839.

Kaldor N. (1978), "The Effects of Devaluation on Trade in Manufactures", in N. Kaldor, *Further Essays in Applied Economics*, London, Duckworth.

Krugman Paul (1987), "The Narrow Moving Band, the Dutch Disease, and the Competitive Consequences of Mrs. Thatcher : Notes on Trade in the Presence of Dynamic Scale Economies", *Journal of Development Economics*, 27, 41-55.

Murat Marina, Francesco Pigliaru (1995), "Crescita ineguale e cambiamento strutturale indotto dal commercio internazionale" in Pugno Maurizio, Maria Luigia Segnana (ed.), *Commercio internazionale e crescita economica*, NIS, Roma, p.149-191.

Padoan Pier Carlo (1997), 'Knowledge Accumulation and Diffusion. Is there a Regional Dimension?", *World Bank Policy Working Paper*, n 1781, forthcoming in A. Bartzokas (ed.), *Technology policy in regional blocs*, Routledge.

Padoan Pier Carlo (1998), "Trade Knowledge Accumulation and Diffusion. A Sectoral Perspective", *Structural Change and Economic Dynamics*, 9.

Pugno Maurizio, Maria Luigia Segnana (1995), *Commercio internazionale e crescita economica*, NIS, Roma.

Wilson Charles (1980), "On General Structure of Ricardian Models with a Continuum of Goods: Applications to Growth, Tariff Theory and Technical Change", *Econometrica*, 48, 1675-1702.