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Globalization, rigidities and national specialization: a dynamic analysis

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Abstract

The paper extends the 'dynamic' economic geography technique to analyze the evolution of national specialization as trade costs decrease. As agglomeration economies arise, due to the decrease of trade costs, countries could benefit from specializing in one sector. Nevertheless, the sector of specialization, as well as the speed of relocation of factors towards this sector, depends crucially on the costs of relocating factors and on comparative advantages. Labor market rigidities and comparative advantages contribute to lock a country in its current specialization pattern slowing relocation of factors. The model is consistent with some stylized facts on specialization and labor market rigidities in OECD countries. © 2002 Elsevier Science B.V. All rights reserved.

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1. Introduction

Globalization could be the catalyst for structural change within countries, as emphasized by the recent literature on Economic Geography. A central message of this literature (see, for instance, Fujita et al., 1999 Chapter 5) is that the decrease in transport costs triggers, at some critical level, the emergence of agglomeration economies. As a consequence, it is profitable for a country to concentrate produc-

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tion in one sector, or in one location. When these agglomeration economies generate increasing returns in one sector (or region) within a country, that country is ready for 'industrial clustering' which would increase its productivity and wages. If there were no costs of relocating factors (labor and capital) from one sector to another, this 'presumption' of factor relocation in production would indeed take place at once, and the country would enjoy the benefits of such change. This suggestive story, though, has two theoretical short-comings. The first is that, as it is based on agglomeration externalities (increasing returns), it typically generates multiple equilibria and an indeterminacy with regards to which one will prevail. The second is that nothing can be said on the speed at which industrial clustering takes place and on which factors affect this speed. To gain insight into both problems we need to model and analyze the dynamics of factor relocation. Moreover, in the study of phenomena in which the transition from one steady state to another may take decades, a coherent economic analysis of such transition dynamics is very important.

The Economic Geography literature has usually relied on 'ad hoc dynamics' to study the stability property of equilibria, justifying it with 'evolutionary game theory'. Atomistic agents converge to equilibria in which strategies are 'evolutionarily stable', meaning that if selected through a myopic 'naturalistic' process, they would prevail in the long run (see Krugman, 1998 or Fujita et al., 1999 Section 1.3, for a description of the intuition). This approach does not allow for intertemporal optimization of the agents and, even worse, is totally silent on costs and speed of convergence towards an equilibrium. We will call this approach the static-evolutionary approach. To overcome these limits, few studies; which we review in some detail in Section 3, consider relocation of factors as a fully dynamic process, accounting for the costs of relocation in a context of intertemporal optimization. Such treatment is more rigorous, insightful and consistent with other areas of dynamic macroeconomic analysis, such as the theory of search in the labor market (see Pissarides, 1985) and the theory of investment (see, for instance, Romer, 1996 Chapter 8). While such dynamic analysis has been applied to regional clustering and geographic agglomeration, it has not been applied to the analysis of the evolution of countries' specialization as trade costs decrease. Extending the analysis to such an important area of trade theory is the contribution of the present paper. An early contribution by Mussa (1978) inquired into the same problem in the frame of the classic Heckscher–Ohlin–Samuelson model but, after that contribution, no further effort has been made in the area. Two models are developed here that analyze the evolution of countries' specialization as trade costs decrease, when factor endowments are equal across countries, and when they are different.

In spite of being mainly a theoretical contribution, the paper also provides some stylized evidence consistent with the model. In Section 2 we show that over time and across OECD countries, higher labor market rigidities and long-run unemployment have been associated with less relocation across sectors. Moreover, while in the early phase of international liberalization (60s), relocation did not always increase countries' specialization, in the later phase (70s and 80s), in spite of its slower pace, relocation always increased the degree of specialization of countries.

The facts described are consistent with the insight provided by our models, while certainly not a rigorous test of it.

The novelty of this paper, therefore, is that rigidities and unemployment are considered as hurdles (costs) to the process of relocating factors towards the most productive specialization pattern. Generally, the labor literature has focused on the effects of labor market rigidities on unemployment (see Blanchard, 1997 Chapter 20 for an easy review) while the welfare effects of trade-induced changes in the specialization pattern have been analyzed in a comparative static context using some version of the Stolper–Samuelson theorem. Little work exists on the interaction among labor market rigidities, trade costs and specialization patterns. The present line of analysis brings attention to these issues.

The rest of the paper is organized as follows: Section 2 presents some stylized facts on labor market rigidities and factor relocation in 12 OECD countries. Section 3 reviews the existing literature on the dynamics of factors relocation in an economy with increasing returns. Section 4 develops the dynamic model in the case of homogeneous factor endowments across countries and studies the role of frictions, freeness of trade and expectations. Section 5 does the same in a world of comparative advantages. Section 6 concludes.

2. Labor market rigidities and relocation in OECD countries

The stylized facts that we present in this section, establish a link, in the long run and across countries, between labor market rigidities and sectorial relocation of factors. In the last 40 years there has been a decrease in the cost of trade (both in the form of improved transportation and lower protections) and this fact has created the pre-conditions for profitable agglomeration economies and has increased international specialization. Nevertheless, the degree of sectorial relocation realized, has depended crucially on the costs of relocating factors (mainly labor) across sectors.

To inquire into this link, we need to somehow capture the different costs of relocating factors across sectors within countries. In order to change sector, a worker quits her job to search for another one; the main cost of relocating labor is, therefore, the period in which the worker is unproductive, i.e. unemployed, or the effort put into her job search.[1] The larger is the pool of long-term unemployed in the country, the larger the risk of remaining unemployed for a long time (or the effort to be done to find a job). The long-term unemployment rate is therefore a proxy for measuring the cost of relocating labor in a country. Additionally, long run unemployment rate is highly correlated, in the long run and in the cross section, with labor market rigidities such as hiring and firing costs (see Lazear, 1990; OECD, 1994 Chapter 8, for an account of this correlation) and it captures, therefore, those costs of relocating labor across sectors as well.

[1] In the model we interpret relocation costs as search effort.

We report data for 12 large OECD countries in Table 1. Figures on long-run unemployment are available in the OECD economic outlook and data on two-digit sector-composition of manufacturing employment are also available in the UNIDO database on industrial structure.[2] We report three variables: the yearly percentage change in sector composition, the yearly percentage increase in specialization and the long-run unemployment rate. All the variables are measured for two sub-periods separated by the first oil shock: 1963–1973 and 1973–1994. Such choice of sub-periods is made because the early 70s was the period of most substantial increase in labor market rigidities in most OECD countries. After that period, until the mid 80s, costs of hiring, firing and unemployment benefits have been much larger than in the 60s. Only after the mid 80s, and rather slowly, were these rigidities reduced (see Blanchard, 1999, p. 12–14 for an history of labor market institutions and also Table 2 in Appendix D for some summary statistics). The long run unemployment rate is measured at the end of each sub-period as some data do not date back to the mid point of the earlier period.

The first index captures the difference in the (two digit) sector-specialization of manufacturing in a country between the end and the beginning of the considered period. It is the same index used by Krugman (1991a) to measure bilateral specialization, but here it is used, rather, to measure the difference in specialization of one country in two different moments in time.[3] The measure is standardized for

Table 1
Rigidities, relocation and specialization in 12 OECD countries

OECD country	Yearly change in sector pattern ($\times 100$)		Yearly change in specialization index ($\times 100$)		Long run unemployment rate	
	1963–1972	1973–1994	1963–1972	1973–1994	1972	1994
Australia	2.11	1.26	0.33	0.17	1.00	3.50
Belgium	1.74	1.28	1.35	0.77	2.69	4.30
Canada	1.04	1.12	−0.08	0.30	0.26	1.30
Finland	1.87	1.28	−0.21	0.23	1.14	3.00
France	1.45	0.96	0.10	0.41	3.01	4.20
Germany	1.27	1.35	0.57	0.91	0.99	3.10
Japan	2.20	1.17	−0.08	0.94	0.30	0.50
Holland	2.02	0.76	−0.20	0.68	1.85	2.90
Norway	2.05	1.46	0.38	0.96	0.03	1.30
Sweden	1.99	1.12	0.54	0.42	0.14	1.10
UK	0.73	1.02	−0.01	0.09	2.76	4.40
USA	1.08	0.92	0.41	0.15	0.83	0.70
Average	1.63	1.14	0.25	0.50	1.24	2.52

[2] Countries are selected based on the availability of data in the time span considered.

[3] Denoting with s_{it} employment in sector i at time t for a country as share of total manufacturing employment, the index is defined as:

the length of the time interval and multiplied by 100. Larger values imply that a country has undergone a larger relocation of factors across sectors.

The second index is the yearly percentage change in the Herfindal index of concentration of employment across (two-digit) sectors in manufacturing. The Herfindal index measures the concentration of a country's manufacturing employment in its two-digit subsectors. The indices reported in column three and four, measure how much the concentration of manufacturing has increased (or decreased if the index is negative) per year, in percentage terms.[4] These two indices certainly depend on the industry classification and on the degree of aggregation chosen. Nevertheless, while it would be risky to compare them directly across countries, it seems more appropriate, because it cleans for differences in scale, to calculate their 'percentage change' for each country and compare this measure across them. These indices have been widely used as measures of bilateral specialization and of industrial concentration (Amiti, 1997; Kim, 1995; Krugman, 1991a). We consider their behavior as a reasonable proxy for, respectively, relocation of labor and increase/decrease of specialization.

Let us first consider the behavior of the average variables across OECD countries (last row in Table 1) over time. We notice that, during the period 1973–1994, countries while becoming increasingly specialized, experienced a slowdown in the speed of relocation of factors compared to the previous decade (1963–1973). Moreover, while some countries such as Japan, The Netherlands, Canada and Finland during the first period experienced a decrease in specialization, in the second period all of them experienced an increase in specialization. The second remarkable difference, looking at the average behavior over the two sub-periods, is the increase in the long-run unemployment rate (from 1.2 to 2.5%) which also corresponds to an increase in some measures of labor market rigidities (see Table 2 in Appendix D).

The stylized story emerging from these facts is consistent with the two models developed below. The early phases of increasing trade openness (the 60s) coincided with a period of low rigidities–low unemployment and therefore low relocation costs. They involved countries which were rather similar in their factor composition (Canada and the U.S., some core European Countries). These two facts together implied that the potential agglomeration economies induced a strong tendency to

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$$\frac{\sum_{i=1}^{N} |s_{it_1} - s_{it_0}|}{t_1 - t_0},$$

where N is the number of two-digits sectors in manufacturing.

[4] Using the same notation as before, the index is described as:

$$\frac{\sum_{i=1}^{N} (s_{it_1})^2 - \sum_{i=1}^{N} (s_{it_0})^2}{(t_1 - t_0)\sum_{i=1}^{N} (s_{it_0})^2}.$$

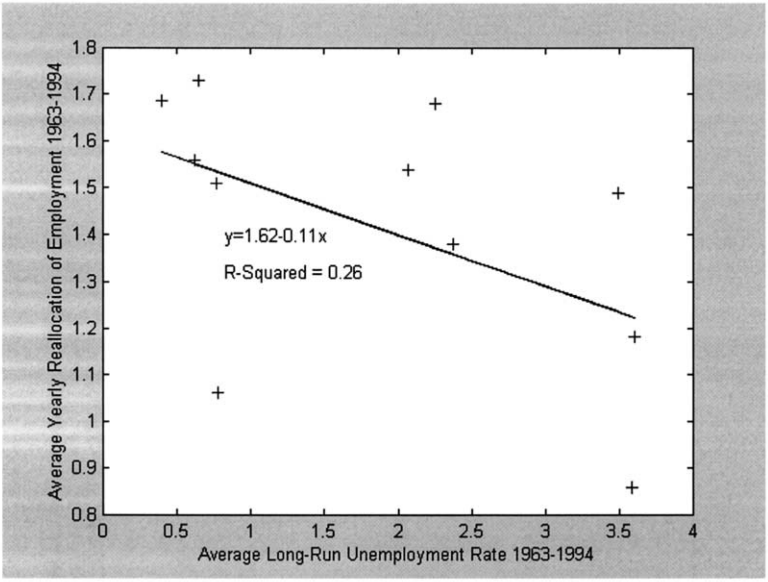

Fig. 1. Relocation of labor across sectors and rigidities.

the relocation of factors with the possibility; in some cases, of decreasing countries' specialization (as is possible in the case analyzed in Section 4). As the process of integration continued in the 70s and 80s, the world experienced an increase in rigidities and long-run unemployment. The increased cost of relocation of labor, and the fact that trade freeness extended to countries with different factor endowments, locked countries in their specialization pattern possibly reinforcing it (as happens in the model analyzed in Section 5).

Also, the cross sectional dimension of the data for the 12 OECD countries considered, is consistent with the idea that labor market rigidities slow relocation of factors. If we consider the average data for the whole period 1963–1994, across the 12 countries, we observe a negative correlation, significant at the 5% level (T-statistic 1.82), between the change in specialization and the average long-run unemployment in the period. This relation is represented in Fig. 1. Countries, in which long run unemployment rates were high, such as France and Belgium, were also those in which the sector specialization was changing more slowly.

These facts are meant to be only suggestive evidence and by no means a rigorous test of our model. They show, though, two potentially interesting tendencies. First, there seems to be a negative correlation between the cost of relocating labor across sectors and the speed at which this relocation takes place. Second, a decrease of countries' specialization indices happened only in the first sub-period, when early trade integration was taking place and labor market rigidities were low. We propose in this paper two dynamic models which explicitly account for the cost of relocating factors across sectors and represent, respectively, the scenario of integration between similarly endowed OECD countries (Section 4) and between differently endowed OECD countries (Section 5).

3. Related literature

This paper is a contribution to the literature on dynamic economic geography. In particular, using the analytical tools developed in Baldwin (2001), it analyzes the dynamic solution paths for a model of industrial specialization, as developed in Fujita et al. (1999) Chapter 16. The economy analyzed has two sectors, and the factors of production are mobile between them but have to make an 'effort' to move from one sector and find employment in the other. This approach generates a much richer set of potential dynamics towards the equilibria, compared to the static-evolutionary approach of Fujita et al. (1999), and allows us to study these dynamics, depending on three key parameters: the 'freeness' of trade, the cost of relocating factors and the strength of comparative advantages. As in Baldwin (2001) we rely on phase diagram techniques, as well as on linearization around the steady state, to characterize the system's behavior.

The seminal works in the area of dynamic analysis of agglomeration are certainly Krugman (1991b), Matsuyama (1991) which both, admittedly, build on Mussa (1978). Both works, as well as the few following works, dealing explicitly with a dynamic model of geographic agglomeration (notably Baldwin, 2001; Ottaviano, 1999), focus on the problem of concentration of production in space, i.e. between two regions. This paper uses the same dynamic tools to study concentration of production between two sectors, reinterpreting the cost of relocating factors as search costs, rather than migration costs.

The first insight gained with the fully dynamic analysis and absent in the static-evolutionary approach, is that the decision to move factors between sectors is an 'investment decision': there is a stream of future benefits to be gained from specialization but there is also a current cost of moving factors. An intertemporally optimizing household compares the present discounted benefits from specialization with the instant cost of moving factors and chooses the optimal speed of relocation. Not only are we able to find the speed of relocation but, in solving this problem dynamically, we realize that a crucial role is played by expectations. For instance, if the cost of moving factors is low and the future is not too heavily discounted, the pattern of specialization can be reversed, if expectation of such reversal arises (see the model in Section 4 below). At least for values of the parameters in some range, expectations rather than history, may determine the equilibrium to which the system converges. It is interesting to notice that with the static-evolutionary approach we would not be able to generate the 'reversal of specialization' which is one of the stylized facts described, for some countries, in Section 2. In the static-evolutionary approach the initial condition always determines the equilibrium which is reached through a progressive increase in specialization.

The second original contribution of the paper is that, in the model developed in Section 5, we analyze an asymmetric situation, assuming that each country has comparative advantages in one sector. All previous models (Krugman, 1991b; Ottaviano, 1999; Baldwin, 2001) considered two perfectly symmetric regions and their potential evolution in response to agglomeration economies. In our analysis, we find that comparative advantages, even in the presence of dynamic decision and agglomeration economies are likely to lock a country in its specialization pattern, as transport costs decrease. The reversal of specialization is not possible when comparative advantages are strong enough.

4. Dynamic symmetric economies

Let us begin with the analysis of two economies, Home and Foreign,[5] with two sectors, having only one factor of production, Labor. We can think of this model as representing very similar countries, with no comparative advantages from different factor endowments, but only potential advantages arising from pecuniary externalities due to concentration of production in one sector. The structure of production, consumption and trade in the model is identical to the one in Fujita et al. (1999) Chapter 16, and we only sketch it, in the text, leaving to the appendix some more details. The novel insight of our approach is that the explicit dynamic analysis allows for reversal of specialization to arise, while such a feature is impossible in the static-evolutionary approach. Also we can characterize the determinants and the speed of convergence towards the specialized equilibrium.

Labor is divisible[6] and is inelastically supplied by atomistic households, whose total number and size in each country is, for simplicity, standardized to 1.[7] Labor may be employed in either of the two industries, which we label sector 1 and 2, it cannot move internationally, but it may move between sectors at a cost which we will define more precisely later. As we maintain the assumption of perfect symmetry between Home and Foreign, both in this and in the following section, we describe the conditions for home, with the understanding that they also hold for Foreign, switching sector 1 with sector 2 and vice-versa.

Each worker/consumer has an instantaneous utility function which is a Cobb–Douglas combination of two composite goods: $U = X_1^{0.5} X_2^{0.5}$. X_1 is a composite index of the consumption of goods $x_1(j)$ manufactured by industry 1 and X_2 is a composite index of the consumption of goods $x_2(j)$ manufactured by industry 2. The elasticity of substitution between two goods within each composite is equal to σ.

[5] The tilde character $\sim$ on top of a variable will denote that it is relative to the foreign economy.

[6] The assumption of labor divisibility is as in Baldwin (2001). As long as the single family is taking as given the productivity of labor in each sector, this assumption gives the same optimality conditions as in Krugman (1991b).

[7] This means that the total supply of labor from a household is 1 and the total supply of labor in the economy is also 1.

Shipping goods between the two countries involves iceberg 'trade' cost $T > 1$. Only a fraction $1/T$ of the shipped good arrives to destination. Both industry 1 and 2 are monopolistically competitive. The production function for the good j in industry i requires a composite input 'bundle' defined as Cobb–Douglas aggregate of labor, 'own' intermediates and 'cross' intermediates, with cost shares, respectively, β, α, γ.[8] The 'bundle' uses more intermediates from the own industry rather than from the other industry ($\alpha > \gamma$) and this feature generates benefits from agglomeration for transport costs below a certain critical level. The 'bundle' to produce a good is required in a fixed amount F, independent of the total output, and in a variable amount with a constant marginal input requirement (c^{m}).

Given these assumptions we can derive the pricing behavior of a single firm (that produces $x_i(j)$ as a monopolist), the price indexes for composite good X_1 and X_2, which we call G_1 and G_2, and total expenditure for each country in each good. The market clearing conditions for each sector, and the equation defining G_1 and G_2 provide four equations for each country jointly defining prices (G_1, G_2) and wages paid in each sector (ω_1, ω_2) as a function of l_1,[9] which varies between 0 and 1 and is the amount of labor employed in sector 1. As these functions are homogeneous in all prices we can standardize $\omega_1 = 1$. The key variable that we derive from this analysis of consumption and production is the real wage, which is also the instantaneous indirect utility for workers in each sector: $\omega_i = (\omega_i / G_1^{0.5} G_2^{0.5})$.

Let us now define the function $\Omega(l_1)$ as $(\omega_1(l_1) - \omega_2(l_1))$ the differential between real wages paid in sectors 1 and 2. If $\Omega(l_1)$ is positive then it is profitable (in terms of instantaneous utility) to move factors to sector 1 while if it is negative it is profitable to move them to sector 2. If we could obtain a closed form solution for $\Omega(l_1)$ from the described model, we would simply use it as the basis for the dynamic analysis. The best we can do, though, due to the high non-linear structure of the system of equations defining equilibrium, is to simulate it and build the dynamic analysis on its qualitative features. It is possible in particular, to define the qualitative features of the function, depending on the value of parameter T, that captures trade costs. Let us first introduce the rest of the dynamic model and we will consider the features of the function $\Omega(l_1)$ when analyzing the dynamic equilibrium.

Households are rational infinitely-lived agents. They decide how to allocate their labor in each sector in order to maximize their infinite horizon lifetime utility. In shifting labor from one sector to another, households incur in a cost due to a search process in the industry to which they are moving their labor. The easiest way to think of it is as the disutility from the effort to find a job in the new sector. Due to crowding effects, the effort required is higher the larger the flow of people towards the sector and the higher the total number of workers already in the sector. Moreover, the effort is larger, the higher labor market rigidities are, that is the less efficient the labor market is in promoting the right 'match' of workers and

[8] $\alpha + \gamma + \beta = 1$.

[9] The equations are Eqs. (16) and (19) in the Appendix A.

enterprises. Very regulated labor contracts and hiring procedures, as developed in several European countries in the early 70s, could result in high effort and disutility to relocate labor. For simplicity, therefore, we consider the cost of relocation as a non-monetary cost, so that the personal income of agents will not be affected by it. Moreover, we assume that labor market rigidities will cause higher effort of relocation but no period of unemployment, in order to maintain the easy features of a full employment model. It is reasonable, though, to think that, as shown in Section 2, the rigidities causing costs of relocation are also those that cause long spells of unemployment.

The instant utility of a household is given by the real wage less a cost of 'changing sector' which is quadratic in the flow of workers between sectors and is increasing with the overall number of workers in the sector to which labor is moved.[10] In particular we assume that it becomes infinitely costly to move labor into one sector when already all workers are in it. We think that this assumption captures realistic crowding externalities which may derive from the increasing difficulty in moving factors towards a sector, if that sector is already very crowded. This assumption, which is harmless as it does not change the qualitative behavior of the system's dynamics, implies that on the equilibrium trajectory, the corner allocation (all workers in one sector) will be reached only asymptotically.[11] Assuming an inter-temporal discount rate equal to r we may write the lifetime utility of the i-th household as:

$$\int_{t=0}^{\infty} \mathrm{e}^{-rt}\left(l_{1i}\omega_1 + (1-l_{1i})\omega_2 - \frac{\phi m^2}{2[(1-l_1)I_m + l_1(1-I_m)]}\right) \mathrm{d}t, \tag{1}$$

where l_{1i} and $(1-l_{1i})$ are the amount of labor supplied in industry 1 and 2 by the i-th household, ϕ is the parameter capturing the institutional costs of relocation, $m=\dot{l}_{1i}$ is the instant rate at which the household moves labor from industry 2 to 1 while I_m is an indicator whose value is 1 if $m \geq 0$ and 0 if $m<0$. The optimal programming problem, solved by a household, maximizing the current-value Hamiltonian implies the following conditions:

$$\frac{\phi m}{(1-l_1)I_m + l_1(1-I_m)} = \lambda, \tag{2}$$

$$\dot{\lambda} = r\lambda - (\omega_1 - \omega_2). \tag{3}$$

Plus the transversality condition $\lim_{t\to\infty} \lambda l_1 \mathrm{e}^{-rt} = 0$.

λ is the costate variable, equal to the shadow value of moving labor from sector 2 to 1. Therefore, when its value is positive and large, households will have strong incentives to move labor quickly from sector 2 to 1, vice-versa if its value is

[10] We assume no international asset market.

[11] This assumption, only slightly different from Baldwin (2001), is enough to avoid the problem of terminal condition pointed out by Fukao and Benabou (1993). The optimal trajectory, therefore, will be consistent with what was originally thought by Krugman (1991b). I thank one of the referees for helping me to think carefully about this point.

negative and large. As we assumed identical representative households we have: $l_{1i} = l_1$ and $m = \dot{l}_1$ so that, re-arranging Eq. (2) and Eq. (3) we get:

$$\dot{l}_1 = [(1 - l_1)I_m + l_1(1 - I_m)]\frac{\lambda}{\phi}, \tag{4}$$

$$\dot{\lambda} = r\lambda - \Omega(l_1). \tag{5}$$

These two differential equations in λ and l_1 define the global dynamics of the system. We will use the phase diagram method, as well as a linear approximation of this system around the steady state; to understand the behavior of factor allocation when the trading environment becomes more 'free' (T decreases) for different levels of relocation costs (ϕ).

The decrease in trade costs T, for given values of the other parameters, has an impact on the dynamic system as it modifies the shape of the function $\Omega(l_1)$. Notice that change in the parameter T affects only the $\dot{\lambda} = 0$ locus while the $\dot{l}_1 = 0$ locus is unchanged. We analyze the qualitative features of this change,[12] relying on intuition, to explain the change in the shape of $\Omega(l_1)$, while in Appendix B, computer simulations of $\Omega(l_1)$ for different values of T are shown.

For high values of the transport costs, the symmetric de-specialized equilibrium is the only feasible one and it is also saddlepath stable as shown in the phase diagram below.

The locus $\dot{l}_1 = 0$, is represented in Fig. 2, by the three bold segments denoted with $dl_1/dt = 0$. Their equations (from Eq. (4)) are: $\lambda = 0$ for the horizontal part, and $l_1 = 0$, $\lambda < 0$ and $l_1 = 1$, $\lambda > 0$ for the two vertical parts. This locus does not depend on the value of T and it is the same in all different cases. The locus $\dot{\lambda} = 0$ (denoted with $d\lambda/dt = 0$) is represented by the bold curve, whose equation is (from Eq. (5)) $\lambda = \Omega(l_1)/r$. Its shape depends therefore on the shape of $\Omega(l_1)$, as it is exactly that function re-scaled for a constant. In this case, as transport costs are high and therefore the price of imported goods is high, a large part of the demand for

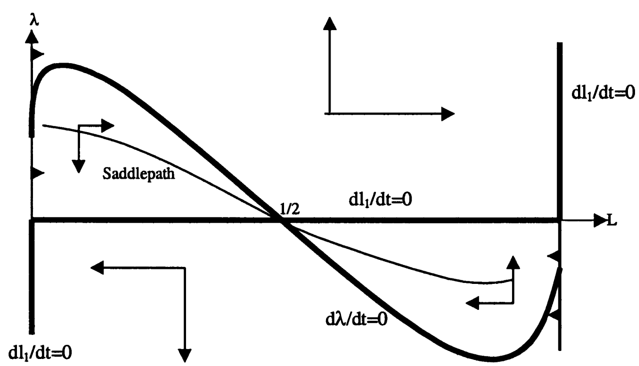

Fig. 2. Phase diagram for high transport costs.

[12] The phase diagrams in the text are therefore schematic representations not simulations.

domestically produced goods is also domestic. Increasing the specialization in one sector increases competition and hurts the industry. As labor concentrates in one sector, that sector suffers from this increased competition and the wage it pays decreases. Therefore, the country should move from any initial allocation towards a balanced allocation of labor between the two sectors, and the optimal way of doing it, is choosing the trajectory on the saddlepath.

Locally, i.e. near the steady state, the saddlepath stability of the equilibrium could be formally proven by linearizing the system around its steady state and noting that the characteristic roots of the resulting linear differential equation system are:[13]

$$\mu_{1,2} = \frac{r \pm \sqrt{r^2 - (\mathrm{d}\Omega/\mathrm{d}l_1)(2/\phi)}}{2}. \tag{6}$$

As $\Omega(l_1)$, has a negative first derivative in the symmetric equilibrium (see Fig. 7 in the Appendix B), this ensures the existence of one positive and one negative characteristic root, which characterize a saddlepath stable equilibrium.

As transport costs decrease, the shape of $\Omega(l_1)$ changes. The increased international trade makes it profitable to exploit the pecuniary externalities of co-location for firms in the same industry. This generates, at first, the sustainability of the fully specialized equilibria while also creating two intermediate unstable equilibria (as in Fig. 8 in the Appendix B). As the transport costs decrease further, the strength of agglomeration economies prevails globally on the 'local competition effect'. The function $\Omega(l_1)$ becomes an increasing function over the whole interval $l_1 \in [0, 1]$ and it is, therefore, upward sloping at the symmetric allocation (see Fig. 9). The dynamics of specialization in this case are particularly interesting: assuming historical decline in trade costs, when this configuration arises the economy experiences for the first time the instability of the symmetric equilibrium. As in Krugman (1991b) the dynamics of the system, beginning from the symmetric allocation which has been determined by the past history, depend crucially on the size of the relocation costs. If they are large enough ($\phi > (\mathrm{d}\Omega/\mathrm{d}l_1)(2/r^2)$)[14] the path towards the equilibrium would be monotonically increasing (as in Fig. 3). Any little advantage in one sector achieved during this crucial period will result in progressive specialization in that sector. In this case the trajectory described in Fig. 3 is optimal and complete specialization is reached only asymptotically, satisfying the transversality condition.[15] Any other trajectory would imply ever accelerating values of λ, violating the transversality condition.

On the other hand, if the cost of relocating labor are low ($\phi < (\mathrm{d}\Omega/\mathrm{d}l_1)(2/r^2)$), we have the dynamics described in Fig. 4.[16] In this case the path leading to 1 (as well

[13] We use the fact that $[(1-l_1)I_m + l_1(1-I_m)]$ is equal to 1/2 for $l_1 = 1/2$.

[14] In this case the characteristic roots of the linear approximation around the symmetric equilibrium will be both real and positive.

[15] The corner allocation is not reached in finite time because of the assumed dynamics of l_1.

[16] In this case the characteristic roots of the linearized system are complex with positive real part.

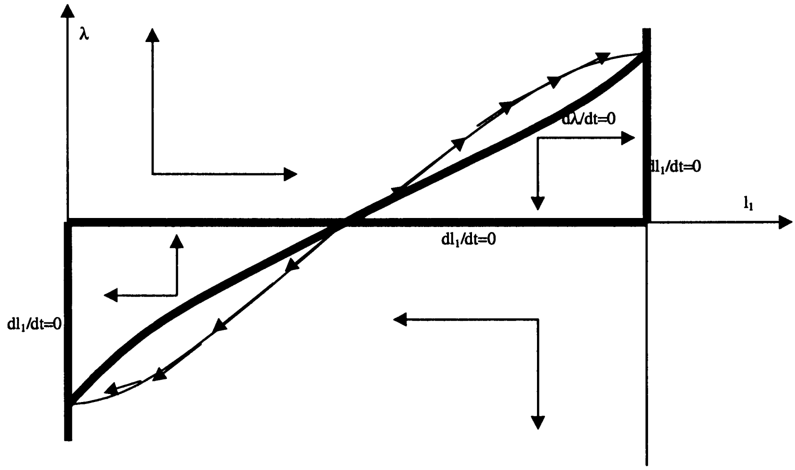

Fig. 3. Phase diagram with low trade costs (T) and high labor market rigidities (ϕ).

as the one leading to 2) is spiraling out of the unstable equilibrium. This feature give rise to multiple self-fulfilling equilibria, and to an area of 'overlap' of the two dynamics, so that expectations may crucially drive the pattern of specialization. Countries where relocation costs are low could therefore also reverse their specialization pattern if expectation in this sense arises, which is a novel feature compared to the static-evolutionary approach.

The novel insight that we derive from the present analysis, as compared to the static-evolutionary one, is that we are able to understand reversals of specialization as result of low relocation costs and changing expectations. We are also able to

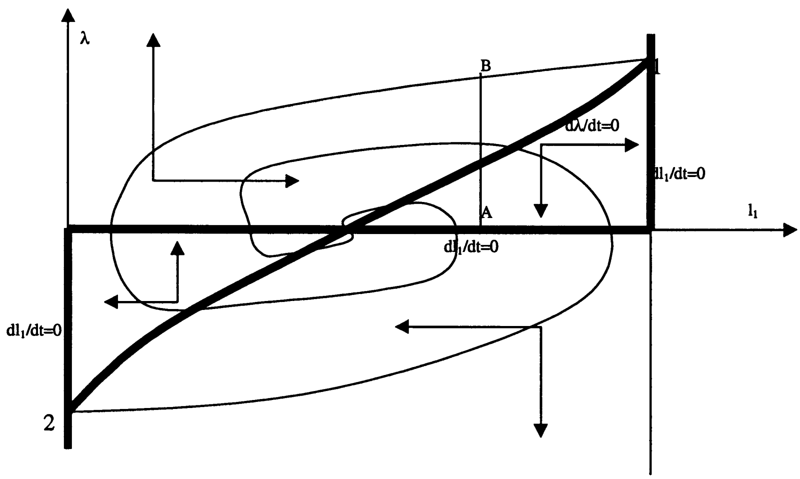

Fig. 4. Phase diagram when trade costs (T) are low and labor market rigidities (ϕ) are also low.

determine the speed of relocation and how it depends on relocation costs, given by the search effort.

5. Economies with comparative advantages

One feature of the previous model is less than satisfactory if we want to gain some insight on the dynamics towards specialization of some OECD countries, whose factor endowment is not similar. The model does not incorporate any force of comparative advantages, assuming the two sectors as totally symmetric and all workers as completely homogeneous. Often, though, the specialization of countries, even within OECD, depends on the relative endowments of skills in their labor force. We remove such simplification in this section, assuming that there are two types of labor and that each country has a comparative advantage in one of the two types. We consider a case in which countries have rather strong comparative advantages to show more effectively what are the consequences of a departure from the symmetric case. The static model in this section is an Hechkscher–Ohlin model augmented for agglomeration economies, as in Fujita et al. (1999) Chapter 16.5. The key insight gained using dynamic analysis is that now when transport costs decrease, comparative advantages may[17] lock a country in its specialization pattern, if they are strong enough, preventing reversals of specialization even with low costs of factor relocation.

Without loss of generality we assume that Home is relatively abundant in unskilled workers (L) while Foreign is relatively abundant in skilled (H). Also, to maintain symmetry, we assume that the relative endowments of the two countries are exactly reciprocal ($\bar{L}/\bar{H} = \bar{H}/\bar{L} > 1$) and that the two countries, if no transport costs existed, would be in the same Factor Price Equalization cone.[18]

At the same time we modify the production function of goods in the two sectors, and we make sector 1 the 'unskilled-labor' intensive sector. We assume that the input bundle used in sector 1, rather than using just labor as one of the inputs (together with 'own' and 'cross' intermediates) uses a composite labor input q_1 which is more intensive in unskilled workers: $q_1 = l_1^{\delta} h_1^{1-\delta}$. l_1 is the unskilled worker input, h_1 is the skilled worker input and $\delta > 0.5$ is the elasticity of the composite labor input to the supply of unskilled worker. Symmetrically, sector 2 uses a composite labor input q_2 which is more intensive in skilled worker $q_2 = l_2^{1-\delta} h_2^{\delta}$. Choosing units of these composite labor inputs appropriately, the minimum cost of obtaining them is, respectively, $v_1 = r_L^{\delta} r_H^{1-\delta}$ and $v_2 = r_L^{1-\delta} r_H^{\delta}$, where r_L and r_H are the cost of unskilled and skilled labor.

[17] Indeterminacy of equilibria for intermediate values of transport costs still exists. We discuss this issue below and in the appendix in more detail.

[18] The technical condition for this is: $(1-\delta)/\delta < \bar{L}/\bar{H} < \bar{L}/\bar{H} < \delta/(1-\delta)$. Evidence that OECD countries are in the same diversification cone can be found in Cuñat (1999).

Given the endowments of skilled and unskilled labor ($\bar{L}$ and $\bar{H}$), the country has a Production Possibility Frontier (PPF) for the provision of q_1 and q_2. The PPF implicitly defines a function $q_2 = f(q_1)$ that captures the efficient (minimum cost) transformation of q_1 into q_2 and its slope is, therefore, $(-v_1/v_2)$.[19] On the other hand, the zero profit and market clearing conditions, define the real market price of the two labor intermediates, ω_1 and ω_2.[20]

The representative household in this model supplies inelastically the average amount of L and H in the economy. It decides how to allocate factors by comparing the relative costs of providing the composite labor inputs in each sector (v_1/v_2), with their relative real prices (ω_1/ω_2). The interior allocation $(q_1 \in (0, 1))$[21] for which the two terms are equal is a potential equilibrium. In fact, it corresponds to the tangency condition between the PPF and the instant isorevenue line for the family. If no such point exists, then there will be a corner solution: full specialization in sector 1 prevails if $\omega_1/\omega_2 > v_1/v_2$ for $q_1 = 1$, while full specialization in 2 requires that $\omega_1/\omega_2 < v_1/v_2$ for $q_1 = 0$. In particular, for the rest of the analysis it is convenient to define the function $\Psi(q_1) = \omega_1 - (v_1/v_2)\omega_2$. Depending on its sign, the instant utility of shifting factor to sector 1 will be positive (if $\Psi(q_1) > 0$) or negative (if $\Psi(q_1) < 0$) and therefore this function, together with relocation costs, determines the dynamic behavior of the households.

The instant real income of a household is given by $(\omega_1 q_1 + \omega_2 q_2)$. Factors are moved efficiently between composites on the PPF so that $q_2 = f(q_1)$. Assuming the same kind of 'relocation costs' as before, the representative household solves the following problem:

$$\max\left[\int_{t=0}^{\infty} e^{rt}\left(q_{1i}\omega_1 + f(q_{1i})\omega_2 - \frac{\phi m^2}{2[(1-l_1)I_m + l_1(1-I_m)]}\right)dt\right], \tag{7}$$

with $m = \dot{q}_{1i}$. The first order conditions for optimality, obtained after solving the individual problem, imposing $q_{1i} = q_1$, $m = \dot{q}_1$ and recalling that $f'(q_{1i}) = -(v_1/v_2)$, are simply:

$$\dot{q}_1 = [(1-q_1)I_m + q_1(1-I_m)]\frac{\lambda}{\phi}, \tag{8}$$

$$\dot{\lambda} = r\lambda - \Psi(q_1), \tag{9}$$

with the transversality condition $\lim_{t\to\infty} \lambda q_1 e^{-rt} = 0$. As before λ is the costate variable capturing the shadow value of moving factors from the composite 2 to the composite 1. Again if it is positive, there will be an increase in instant utility if the household moves factors from sector 2 to 1, on the contrary if it is negative the household will move factors in the opposite direction.

We now analyze the dynamics of specialization as trade costs T decrease. As the dynamics of the system hinge crucially on the qualitative shape of $\Psi(q_1)$ we leave

[19] For details on the derivation see Fujita et al. (1999) or Peri (1999).

[20] Specifically, there will be a schedule of (v_1/v_2) as a function of q_1 and a schedule of (ω_1/ω_2), also as a function of q_1.

[21] Given our standardizations the maximum amount of q_1 (and q_2) which could be provided is 1.

to Appendix C the simulations of this function at different values of T, relying here on intuitive explanation.

Three qualitatively different cases emerge from the analysis for progressively decreasing trade costs T. We refer to them as the 'high', 'intermediate' and 'low' costs of trade, and we focus on them. In Appendix C we describe the evolution of the function $\Psi(q_1)$ for the whole range of values of T. In the case of 'high' costs (Fig. 10 in the Appendix C shows the shape of $\Psi(q_1)$ in this case) the qualitative behavior of the phase diagram is as in the previous model, shown in Fig. 2 in Section 4. The only difference is that the saddlepath stable equilibrium will not be the symmetric allocation. Rather, it will exhibit incomplete specialization in sector 1, as that sector is intensive in the abundant factor. Historically determined specialization, when trade costs are high, will therefore reflect the factor endowment of a country. For the values chosen in our simulation, 70% of the resources of the economy will be employed in sector 1 and only 30% in sector 2. Therefore, once trade costs decrease to the 'intermediate' level (Fig. 11 shows the simulation of $\Psi(q_1)$ for this case), the country starts from a point such as A in Fig. 5, partially specialized in sector 1. In this case no indeterminacy arises, as full agglomeration in sector 1 is, given the dynamic properties of the system, the only allocation that can be reached satisfying the optimality and the terminal conditions. Notice that the function $\Psi(q_1)$, as T decreases, first moves up remaining S-shaped as in Fig. 10, and then becomes positively sloped as in Fig. 5.

The equilibrium with full specialization in sector 1 exists and is stable for T between 1.65 and 1.03. For intermediate values of the transport costs ($1.44 > T > 1.15$) an indeterminacy of equilibria still arises: another stable equilibrium appears in which the country specializes in sector 2, the sector in which the country exhibits comparative disadvantages. Such equilibrium is sustained by the strength of linkages and the corresponding function $\Psi(q_1)$ is shown in Fig. 12 in Appendix C. Such possibility of a country specializing in the sector in which it does not have comparative advantages is discussed, using a similar model, in Amity (2001). We show, though, that this possibility arises for a range of values of T which is a subset of the range in which a stable equilibrium exists with complete specialization of the country in sector 1 ($1.65 > T > 1.03$). If we think, therefore, that transport costs are historically declining, once they decrease below $T = 1.67$ the economy begins to converge to the fully specialized equilibrium in the sector with comparative advantages. It is likely that the system continues to converge to that equilibrium, even when the other stable equilibrium arises unless some change in expectations arise.

As trade costs fall below the threshold that generates instability of the partially specialized equilibrium, the system jumps to a point as B in Fig. 5 and move towards equilibrium 1 on the drawn saddlepath. Interestingly in this case, we can also analyze precisely the trajectory and speed of adjustment of the economy towards the equilibrium 1. It is easy to calculate the linear approximation of the dynamic system near point 1. Its characteristic roots are $(-\Psi(q_1)/\phi r, r)$ and the equation of the saddlepath is:[22]

[22] We obtain the saddlepath by choosing the solution which set to 0 the diverging term ce^{rt}.

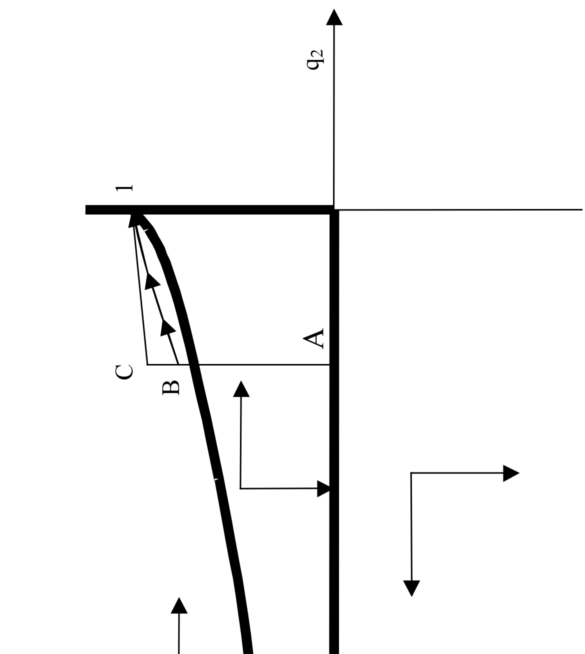

Fig. 5. Phase diagram with comparative advantages and intermediate trade costs.

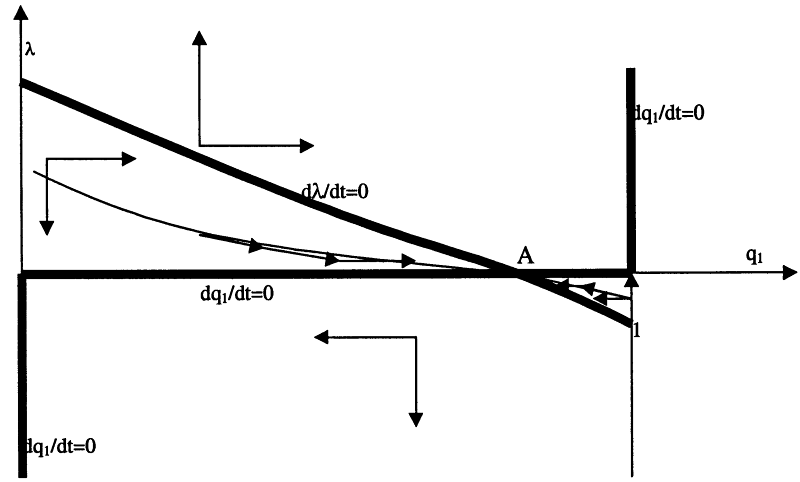

Fig. 6. Phase diagram with comparative advantages and low trade costs (T).

$$(\lambda - \lambda^*) = \frac{\Psi'(1)}{r + (\Psi(1)/r\phi)}(q_1 - 1), \tag{10}$$

where $\lambda^* = \Psi(1)/r$ is the equilibrium level of λ. The speed of convergence of q_1 towards its steady state is $\Psi(1)/r\phi$. Higher costs of relocating factors, therefore, cause the economy to move more slowly on a steeper saddlepath such as the one between B and 1 towards full specialization, while lower costs of relocation speed up the process of convergence towards full specialization, on a flatter saddlepath such as the one between C and 1. Doubling the costs of relocation will result in doubling the time to cover the half distance to the saddlepath.

Finally, for T decreasing further (below 1.03), we have that the extremely low trade costs make agglomeration economies less relevant and therefore incomplete specialization emerges back again, just as in the standard Hecksher–Ohlin model where comparative advantages drive specialization. In this case point A (in Fig. 6) is the only saddlepath-stable equilibrium and the economy evolves towards it, as shown in Fig. 6, if the starting point is a higher level of specialization.

Given the extremely low level of trade costs at which this scenario emerges ($T < 1.03$ in our simulation), and also given the stylized behavior of OECD countries shown in Section 4, this last scenario seems yet to come, potentially as further evolution of trade integration.

Comparative advantages are therefore, together with relocation costs, a critical force in determining the specialization pattern in which a country can be locked in as freeness of trade increases. Reversal of specialization, which was a potential feature of the dynamic model analyzed in Section 4 as well as in other economic geography models (Krugman, 1991b; Baldwin, 2001) is now less likely to happen as countries should converge to a stable equilibrium, specializing in sectors in which they have comparative advantages.

6. Conclusions

The paper has presented the analysis of the evolution of countries' specialization patterns as trade costs decrease, using a dynamic model and paying special attention to the costs of labor relocation. Besides being an extension of the existing dynamic economic geography techniques to the analysis of countries' specialization patterns, which is a key issue in international trade, it provides interesting insight into the interaction between labor market rigidities, trade liberalization and specialization of countries. It also supports a story which is consistent with the evolution of rigidities and specialization in OECD countries, although it is certainly not the only story consistent with those facts. Let us summarize it.

The early phase of trade liberalization and decreasing trade costs (the 60s) could be represented by a scenario as in Fig. 4. Because of relatively small labor market rigidities and high similarity in the endowments of trading partners, the increased liberalization could generate large relocation of factors in this phase, even reversing the existing specialization pattern. In this period, in fact, vis-a-vis a large relocation across sector, not all countries strengthen their specialization pattern. The following phase of trade liberalization (70s and 80s) is well represented, on the other hand, by a scenario as in Fig. 3 or Fig. 5. In this case, higher costs of relocating factors due to increased labor market rigidities and the different factor endowments of countries participating in international trade, slowed down the speed of factors' relocation. At the same time, the historically determined pattern of specialization, due to comparative advantages (Fig. 5) or just to accident (Fig. 3), became more important in affecting specialization, and countries were locked into their specialization pattern. Moreover, considering the scenario represented in Fig. 6, when trade costs become extremely small in a world of comparative advantages, we should not necessarily expect further increase in specialization across countries for the future.

These models are still used in a rather 'heuristic' way to explain the stylized facts, as their simplicity (for instance the fact that they are just two-country models) does not allow us to model closely the process of decrease in trade costs across OECD countries. Nevertheless, the analysis gives interesting results which would not have been captured by the static model. The relationship between relocation and increased specialization as rigidities increase can be analyzed only using a dynamic model. Moreover, this method allows for an analysis of the effect of rigidities when sectorial transformation is taking place in a country. We could complement, therefore, the analysis of rigidities done by the macro and labor literature with this one, done from a 'trade' perspective, to achieve a more complete and thorough understanding of the benefits from the removal of such rigidities, which most countries (especially in Europe) have recently undertaken.

Acknowledgements

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Appendix A. The symmetric static model

The composite good X_i is defined as:

$$X_i = \left[\int_0^{n_i} x_i(j)^{(\sigma-1)/\sigma}\, \mathrm{d}j \right]^{\sigma/(\sigma-1)}, \quad \sigma > 1. \tag{11}$$

It is easy to recognize that Eq. (11) is a constant-elasticity-of-substitution function where σ is the elasticity of substitution between any two varieties. n_i is the number of varieties produced in industry i. The compensated demand function for the zth variety produced in industry i is, therefore:

$$x_i(z) = x_i = \left[\frac{p_i(z)}{G_i} \right]^{-\sigma} X_i, \tag{12}$$

where G_i is the price-index (minimum cost) for the composite good X_i[23] and $X_i = Y/2G_i$, $i = 1, 2$, because of the symmetric spending of consumers' income (Y) in the two sectors.

Optimal pricing implies prices equal to a mark-up on production costs. Given the production function described in Section 4 we have:

$$p_i(j) = \omega_i^{\beta} G_i^{\alpha} G_{-i}^{\gamma}, \tag{13}$$

where we have chosen units so that the marginal input requirement equals the price-cost mark-up ($c^{\mathrm{m}} = (\sigma - 1)/\sigma$), getting rid of a constant. ω_i is the wage rate paid in industry i. The index $-i$ denotes the sector different from i. The zero-profit condition due to free entry and exit implies that the equilibrium output for firm j in sector i is,

$$x^* = F\sigma. \tag{14}$$

By choosing the fixed cost appropriately so that $x^* = 1/\beta$ (again to avoid carrying around a constant, and without loss of generality), the total labor income in industry i is given by,

---

[23] $G_i \equiv [\int_0^{n_i} p_i(j)^{1-\sigma}\, \mathrm{d}j]^{1/(1-\sigma)}$, where $p_i(j)$ is the price of each manufactured good j produced in industry $i = 1, 2$.

$$\omega_i l_i = n_i p_i, \tag{15}$$

where l_i is the labor share employed in industry i and $l_i + l_{-i} = 1$. The price index for the Home economy in industry i is:

$$G_i^{1-\sigma} = l_i \omega_i^{1-\beta\sigma} G_i^{-\alpha\sigma} G_{-i}^{-\gamma\sigma} + \tilde{l}_i \tilde{\omega}_i^{1-\beta\sigma} \tilde{G}_i^{-\alpha\sigma} \tilde{G}_{-i}^{-\gamma\sigma} T^{1-\sigma}, \tag{16}$$

which holds for $i = 1, 2$. Analogous expressions hold for the price index of industry $-i$ in the Foreign economy. Total expenditure from the Home country in industry 1 and 2 are:

$$E_1 = \left[\frac{\omega_1 l_1 + \omega_2 l_2}{2}\right] + \left[\frac{\alpha\omega_1 l_1 + \gamma\omega_2 l_2}{\beta}\right], \tag{17}$$

$$E_2 = \left[\frac{\omega_2 l_2 + \omega_1 l_1}{2}\right] + \left[\frac{\alpha\omega_2 l_2 + \gamma\omega_1 l_1}{\beta}\right]. \tag{18}$$

At last, the market-clearing condition for industry i in the Home economy is,

$$(p_i(j))^{\sigma} = \beta[E_i G_i^{\sigma-1} + \tilde{E}_i(\tilde{G}_i)^{\sigma-1} T^{1-\sigma}]. \tag{19}$$

By the Walras law, the market will also clear for industry $-i$ in the Home country; a market-clearing condition similar and symmetric to Eq. (19) holds for the Foreign economy.

Substituting expression Eqs. (13), (17) and (18) into Eq. (19) and using the two conditions Eq. (16) we have three non-linear equations, which together with the normalization $\omega_1 = 1$ define the three variables ω_2, G_1, and G_2 as function of l_1. The symmetry of the set-up guarantees that the variables in Foreign relative to sector 1 are identical to the variables in home relative to sector 2 and vice-versa, and therefore that $\tilde{l}_1 = 1 - l_1$.

Appendix B. Simulation of $\Omega(l_1)$ for different values of T

Given the key role of the function $\Omega(l_1)$ for the dynamic analysis, we show the simulated behavior of that function, focusing on differences as T decreases, once the other parameters are kept constant at the following values: $\alpha = 0.4$, $\gamma = 0$, $\beta = 0.6$, $\sigma = 5$, $\bar{L} = 1$. The chosen values imply that the agglomerating forces are rather strong as the use of own inputs is large, while there is no use of 'cross' inputs. Tendency towards agglomeration would be reached already for relatively high transport costs. This is done just to make the case clear, while the critical values of transport costs should not be taken too seriously.

For high value of the trade cost parameter ($T = 1.9$) the function $\Omega(l_1)$ is as in Fig. 7. The only allocation that equates real wages and represents a potential equilibrium is $l_1 = 1/2$ while the fully specialized allocation implies that it would be profitable for workers in that sector to move to the other, as they would earn a positive wage differential.

For lower trade cost ($T = 1.7$, see Fig. 8 below) there will be three values for which $\Omega(s_L) = 0$ and the fully specialized cases also represent potential equilibria as $\Omega(0) < 0$, and $\Omega(1) > 0$.

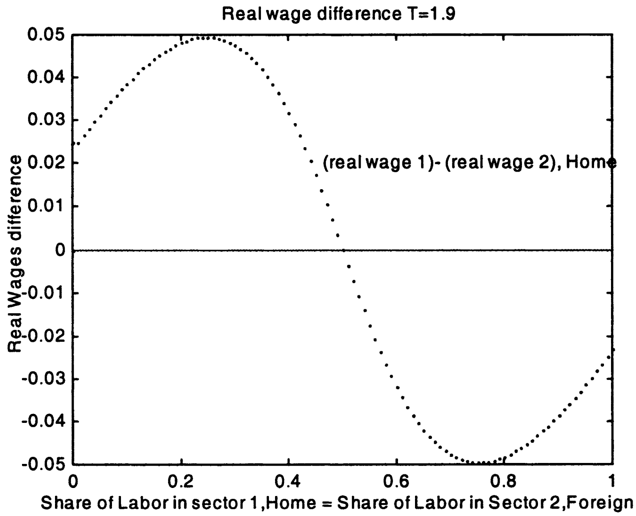

Fig. 7. $\Omega(l_1)$ for $T = 1.9$.

Finally for even lower trade cost ($T = 1.5$ and lower), the function $\Omega(l_1)$ will be upward sloping, still equal to zero at the symmetric equilibrium. Complete specialization in 1 or 2 are both potential equilibria. This situation is illustrated in Fig. 9 below.

Notice that the function $\Omega(l_1)$, although non-linear, is approximated pretty well by a linear function near the symmetric equilibrium and in the case $T = 1.9$ and 1.5 it could also be globally ($0 \leq l_1 \leq 1$) approximated by a linear function (the tangent

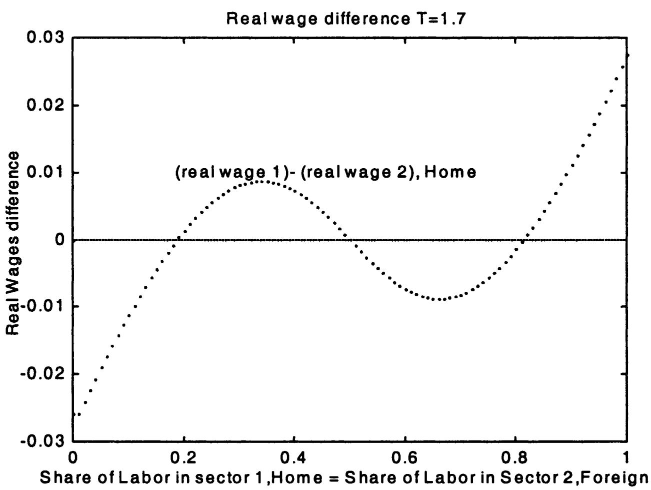

Fig. 8. $\Omega(l_1)$ for $T = 1.7$.

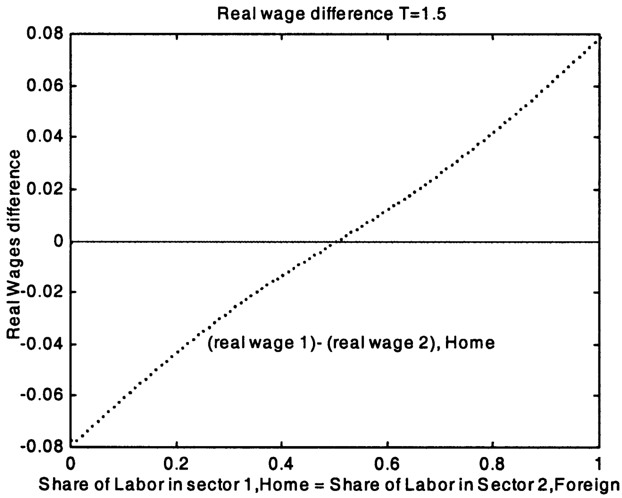

Fig. 9. $\Omega(l_1)$ for $T=1.5$.

line in $l_1 = 1/2$) without misinterpreting its qualitative features. We consider the linear approximation when analyzing saddlepath stability of the equilibria. Finally notice that for decreasing values of T (< 1.5) the function $\Omega(l_1)$ becomes flatter and flatter.

Appendix C. Simulation of $\Psi(q_i)$ for different values of T

The shape of the function $\Psi(q_i)$ fully determines the $\dot{\lambda} = 0$ locus. Here we simulate and comment on its behavior as T decreases. The values of the other parameters are: $\alpha = 0.4$, $\gamma = 0$, $\delta = 0.6$, $\beta = 0.6$, $\sigma = 5\bar{L} = 0.55$, $\bar{H} = 0.45$, $\tilde{L} = 0.45$, $\tilde{H} = 0.55$. The analysis aims at being insightful, rather than matching exactly the parameters for OECD countries. Notice, nevertheless, that we have chosen different but close enough endowments of factors (about 20% difference) to represent different countries within the same diversification cone, as is the case for OECD.

For relatively high trade cost ($T = 1.7$), the function $\Psi(q_1)$ for the home country is shown in Fig. 10.

The only sustainable equilibrium is the one where home is partially specialized in sector one, in which it has comparative advantages. The relatively large endowment of unskilled labor makes Home better at producing in sector 1 even with large trade costs. Therefore, even before trade liberalization begins, Home produces intensively the good for which it has (absolute) advantages. When trade costs fall, a threshold is reached at which the partially specialized equilibrium disappears; agglomeration economies become important as the country could serve the whole world market. Clearly, its comparative advantages in sector 1, makes full specialization in that

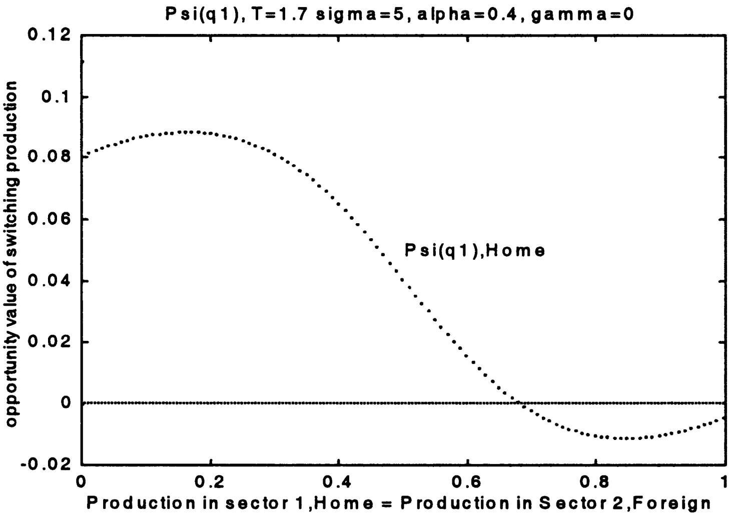

Fig. 10. $\Psi(q_1)$ for $T=1.7$.

sector the only equilibrium that could be achieved. The function $\Psi(q_1)$ shifts up keeping the S-shape as in Fig. 10, and between the values $T=1.67$ and 1.44 it is completely above the zero line. For $T<1.50$ it also becomes globally positively sloped, as shown in Fig. 11, when trade costs are $T=1.5$.

A potential equilibrium arises with full specialization in sector 2, for $T<1.44$ and $T>1.15$ and therefore there is indeterminacy of equilibria in this range. The function $\Psi(q_1)$ has, in fact, a parallel shift down from its position in Fig. 11 for T

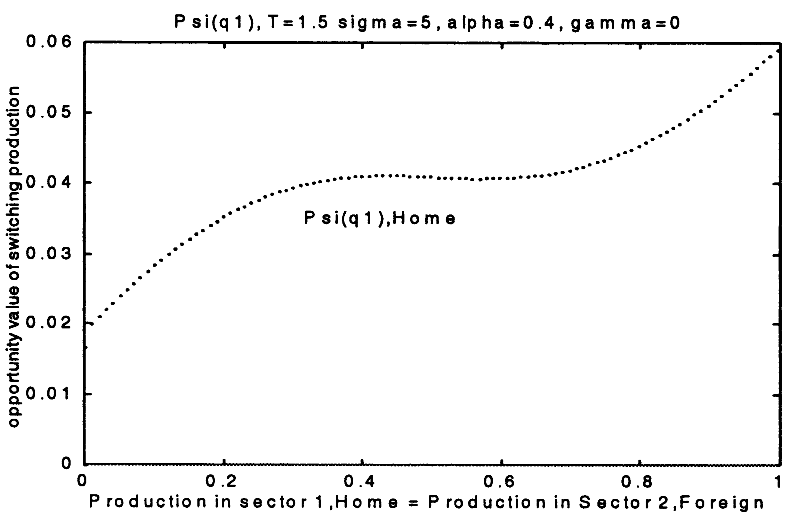

Fig. 11. $\Psi(q_1)$ for $T=1.5$.

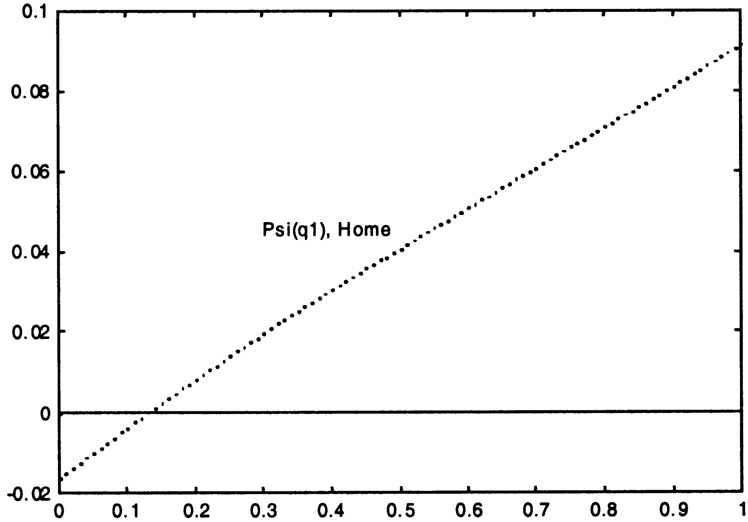

Fig. 12. $\Psi(q_1)$ for $T = 1.35$.

decreasing further. As shown in Fig. 12 the equilibrium with full specialization in sector 2 is stable for instance, at $T = 1.35$. We consider this second stable equilibrium less relevant, though, as it is generated as T decreases below a threshold which is lower than the one generating the stable equilibrium with specialization in sector 1. If transport costs are gradually declining over time the economy will already be converging to the stable equilibrium with full specialization in sector 1, as T decreases below 1.44. As that equilibrium remains stable the system will probably continue to converge towards that equilibrium, unless a change in expectations arise.

For $T < 1.15$ and $T > 1.04$ the curve becomes progressively flat, and then downward sloping again, but is completely above the zero line.

Finally, for very low transport costs ($T < 1.03$) agglomeration economies become less relevant (intermediates are imported at low costs) and the fully specialized equilibrium becomes unsustainable as the pressure on the factor price, used intensively, becomes too high. $\Psi(q_1)$ becomes as in Fig. 13 below.

In this case, the shadow value of producing in sector 1 is negative, and it is therefore optimal to start moving part of the skilled and unskilled labor away from this sector. The stability properties of the equilibria in this case are basically identical to those in Fig. 10.

The complete gallery of the simulations of $\Psi(q_1)$ for values of the parameter T between 1.70 and 1.00 (progressively decreasing by steps of 0.05) is available from the author upon request.

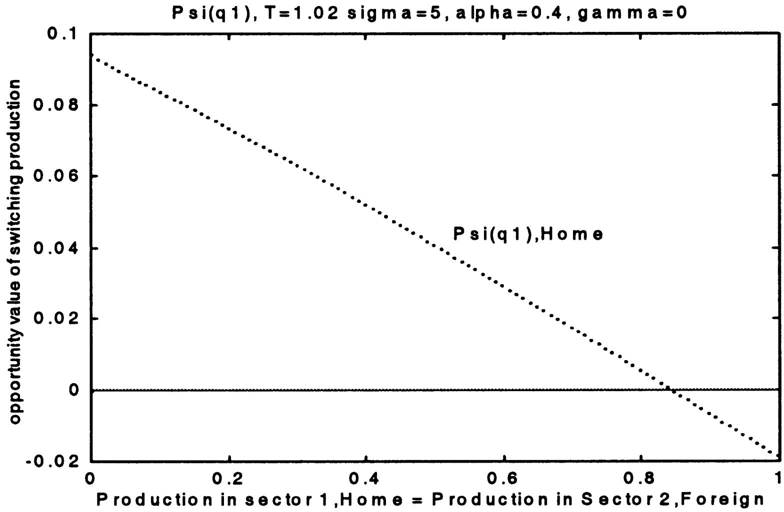

Fig. 13. $\Psi(q_1)$ for $T = 1.03$.

Appendix D. Labor market rigidities in OECD

Table 2 reports the average measures for the OECD countries of three important indicators of labor market rigidities. The source for the first two is Lazear (1990) and for the third is OECD, 1994. 'Severance payments' measures the number of months of salary given to workers as severance pay upon dismissal after 10 years of service. 'Period of Notice' measures the number of months' notice required before termination of jobs for workers with 10 years of service. Finally, 'Unemployment Benefits' is an Index calculated by OECD which accounts for coverage, entitlement and size of unemployment benefits. We have tried to cover two sub-periods, divided by 1973, as close as possible to those used for the stylized facts in Section 2. The exact period for which each variable is measured is written under the entries. All measures increase by a substantial amount passing from the early to the later period.

Table 2
Measures of rigidities in OECD

OECD average	Before 1973	After 1973
Severance payments	3.4 (1963–73)	4.9 (1973–91)
Period of notice	2.04 (1963–73)	2.75 (1973–91)
Unemployment benefits	19 (1967–73)	27 (1973–91)

Source: Author's calculations on Lazear (1990), OECD (1994)

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