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## Trade policy and regional inequalities

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## TRADE POLICY AND REGIONAL INEQUALITIES\*

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### **Abstract:**

This paper aims to analyse the effects of trade policies in the pattern of regional inequalities within a country. Inspired firstly, by the debate concerning the role of protectionist policies in the settlement of a pattern of striking regional inequalities in the Spanish industrialisation process and secondly, by current evidence of an increase in these inequalities following the entry of Spain in the EU (1986), we set a model that shows that trade liberalisation increases regional inequalities.

### **Resum:**

En aquest article s'analitzen els efectes de les polítiques comercials sobre el patró de desigualtats regionals dins un Estat. Establim un model teòric explicatiu, que és una variant del model Krugman-Venables de geografia econòmica i que mostra que la liberalització comercial fa que augmentin les desigualtats regionals. Dues són les fonts d'inspiració d'aquest model, en primer lloc l'establiment d'un patró de colpidores desigualtats durant el procés d'industrialització espanyol i en segon lloc, l'augment d'aquestes desigualtats després de l'entrada de l'Estat espanyol a la UE (1986).

## **Trade Policy and Regional Inequalities**

### Introduction

Krugman and Livas (1996) develop a theoretical model inspired by the case of Mexico that explains the existence of giant Third World metropolis as a consequence of the strong forward and backward linkages that arise when manufacturing tries to serve a small domestic market. When the economy opens up to international trade these linkages are much weaker and a process of dispersion of economic activity takes place.

A similar mechanism could as well explain the pattern of striking regional inequalities that characterized the process of industrialization in most of southern Europe. The paradigmatic case is that of Italy with its industrial north and backward “Mezzogiorno” but Spanish industrialization in the 19<sup>th</sup> century also showed a well-known center-periphery pattern. It was not till the 18<sup>th</sup> century after the defeat of the Catalans in the Spanish War of Succession that the Spanish market was created. At the same time, the end of the 18<sup>th</sup> century and specially the 19<sup>th</sup> century witnessed the process of industrialization in Catalonia while the rest of Spain (with the exception of the Basque Country) stayed backward with an economy still largely based in agriculture. By 1930 the percentage of the population employed in industry in Catalonia attained 53.5 (almost identical to that of England) while that of Spain as a whole (including Catalonia and the Basque Country) was only 34%. In fact, Catalan early development can be analyzed as a cumulative causation process in which the initial advantage of a region is reinforced. This process is even more interesting as an historical example of cumulative causation because

it happened in the political periphery of a unified market not in its administrative capital (Madrid) or in the politically dominant region of the Spanish State (Castile). Political or administrative forces pulling towards agglomeration in the political center do then not reinforce the economic forces at work. The phenomenon of concentration unlike the case in most of Third World countries is not characterized by the formation of huge metropolises but rather by the intense development of one region (or two in the case of Spain) in a quite balanced geographical fashion with several centers of production, some of them in a rural environment, centered around a medium size city.

Historians have traditionally disagreed in the role played by protectionist trade policies in the settlement of this pattern of unequal and unbalanced geography.

Some, mainly represented by N.Sanchez-Albornoz, believe that protectionist policies supported by Catalan cotton producers transformed Castile into a captive market and caused her increased ruralization.

Others, following Jordi Nadal, though recognizing the pernicious effects that protectionist policies had both in Catalonia and Castile, believe that internal factors explain Catalan development despite Spanish underdevelopment.

The fact that the pattern followed by Catalan industrialization is that of a remarkable cumulative causation process is out of the discussion but the role played by trade policy is much more controversial.

In the last forty years, in the context of the development of the welfare state and of highly redistributive transfer policies, a process of income convergence between Spanish regions and nations has taken place. Paradoxically this process has stopped in the 80's, when Spain was joining the EC (1986) and afterwards when she was undertaking the policy measures included in the EC92 package.

Sala-i-Martin (1996, 1997) analyses this convergence process in the context of the neoclassical growth model. He shows that there has been convergence between Spanish regions in the period 1995-1990 but this process has stopped at the beginning of the 80's. Esteban (1994) analyses interregional inequalities in Europe during the period 1980-1989 using inequality indexes. All the indexes show an increase in european interregional inequalities and when this inequality is decomposed in two components, an internal inequality within each country and an external inequality, he shows that it's the internal inequality that has increased during the period while external inequality (between countries) has decreased.

Would that suggest that a free-trade policy is conducive to an aggravation of regional internal disparities and geographical polarization thus contradicting the suggestion that the origin of regional disparities in Spain lies in the protectionist policies followed during the industrialization process?

The theoretical model we will set to explain the pattern of regional inequalities and its relation to trade policy is a version of the Krugman-Venables model. This model, developed principally in Krugman (1991), Venables (1996), and Krugman and Venables (1996), constitutes the theoretical apparatus of the "New Economic Geography".

In the models of economic geography there is always a tension between "centripetal" forces that produce agglomerations and "centrifugal" forces that tend to break such agglomerations.

In this model we use as the centripetal force the interaction of economies of scale, market size and transport costs used for the first time in Krugman (1991) and employed too in Krugman and Livas (1996). The centrifugal force we will use is not in this case the force used by Krugman and Livas (1996) that is commuting-cost/land-rent but the pull of a dispersed rural market like in Krugman (1991). The former is better suited for a urban

model such as Krugman and Livas (1996) that tries to explain the emergence of giant cities while the latter seems more realistic in our context.

### The Model

We consider a world economy consisting of three regions: 1, 2 and 0 (for the outside economy).

All three regions can trade with each other, but labor is mobile only between the “domestic” regions, 1 and 2.

There are two sectors, agriculture and manufacturing.

Agriculture is perfectly competitive and produces a homogeneous good. It is a constant-return sector tied to the land.

Manufacturing is a monopolistically competitive sector and produces a variety of differentiated goods.

All individuals in this economy share a utility function of the form:

$$U = M^m A^{1-m} \quad (1)$$

where  $M$  represents the quantity index of the consumption of manufactured goods and  $A$  is the consumption of the agricultural good.  $m$  is the expenditure share of manufactured goods.

The quantity index  $M$ , is a sub-utility function defined over a continuum of varieties of manufactured goods.  $M$  is defined by a constant elasticity of substitution function:

$$M = \left[ \int_0^n m(i)^r di \right]^{1/r} \quad (2)$$

where  $m(i)$  denotes the consumption of each available variety,  $n$  is the range of varieties produced and the parameter  $r$  represents the intensity of the preference for the variety in manufactured goods.

$s \equiv \frac{1}{1-r}$  represents the elasticity of substitution between any two varieties.

Given income  $Y$  and a set of prices,  $p^A$  for the agricultural good and  $p(i)$  for each manufactured good, the consumer's problem is to maximize utility subject to the budget constraint,  $p^A \cdot A + \int_0^n p(i)m(i)di = Y$ .

We solve this consumer's problem in two steps.

First we have to choose  $m(i)$  so as to minimize the cost of attaining whatever value of the manufacturing aggregate  $M$ .

$$\begin{aligned} \min \int_0^n p(i)m(i)di \\ \text{st} \left[ \int_0^n m(i)^r di \right]^{\frac{1}{r}} = M \end{aligned}$$

The first order condition for this minimization problem gives equality of marginal rates of substitution to price ratios,

$$\frac{m(i)^{r-1}}{m(j)^{r-1}} = \frac{p(i)}{p(j)} \quad (3)$$

Substituting this equation into the original constraint, we have that:

$$m(j) = \frac{p(j)^{\frac{1}{r-1}}}{\left[ \int_0^n p(i)^{\frac{r}{r-1}} di \right]^{\frac{1}{r}}} \cdot M \quad (4)$$

This is the compensated demand function for the  $j$ th variety of manufacturing product.



The expression for the minimum cost of attaining  $M$  is then,

$$\int_0^n p(j)m(j)dj = M \left[ \int_0^n p(i)^{\frac{r}{r-1}} di \right]^{\frac{r-1}{r}} \quad (5)$$

where

$$\left[ \int_0^n p(i)^{\frac{r}{r-1}} di \right]^{\frac{r-1}{r}} \equiv G \quad (6)$$

$G$  is the price index for manufactured goods which measures the minimum cost of purchasing a unit of the composite index  $M$  of manufacturing goods.

Demand for  $j$  can be written as

$$m(j) = \left( \frac{p(j)}{G} \right)^{\frac{1}{r-1}} \cdot M \quad (7)$$

The second step of the consumer's problem is to maximize the overall utility function of the individuals in this economy.

$$\begin{aligned} \max U &= M^m A^{1-m} \\ st \\ G \cdot M + P^A \cdot A &= Y \end{aligned}$$

This maximization problem yields the following uncompensated demand for agriculture and manufacture respectively,

$$A = \frac{(1-m)Y}{P^A} \quad (8)$$

$$m(j) = \frac{p(j)^{-s}}{G^{-(s-1)}} \cdot m \cdot Y \quad \text{for } j \in [0, n] \quad (9)$$

The price elasticity of demand for every available variety is constant and equal to  $\sigma$ .

In our model, we have three different locations for the production and consumption of goods. It is costly to ship goods in all directions. We assume iceberg transport costs. If a good is shipped between either of the two domestic locations only a fraction  $1/T$  arrives. If a good is shipped between either domestic location and the outside world, only a fraction  $1/T_0$  arrives.

If a manufacturing variety produced at location  $r$  is sold at price  $p_r^M$  then the delivered price  $p_{rs}^M$  of that variety at consumption location  $s$  is given by,

$$p_{rs}^M = p_r^M T_{rs}^M \quad \text{for } r = 0,1,2 \text{ and } s = 0,1,2$$

$$T_{rs} = T \quad \text{when } r = 1 \text{ and } s = 2$$

$$\text{or } r = 2 \text{ and } s = 1$$

$$T_{rs} = T_0 \quad \text{when } s = 0 \text{ and } r = 1,2$$

$$\text{or } r = 0 \text{ and } s = 1,2$$

The manufacturing price index may take a different value in each location. Assuming that price is constant across varieties in each location ( $p(i) = p_r$ ) and Iceberg transport costs, the price index in location  $s$  is given by,

$$G_s = \left[ \sum_r n_r (p_r^M T_{rs}^M)^{-(s-1)} \right]^{-1/(s-1)} \quad (10)$$

And now consumption demand in location  $s$  for a good produced in  $r$  is given by,

$$m_s(j) = \mathbf{m} \cdot Y_s (p_r^M T_{rs}^M)^{-s} G_s^{s-1} \quad (11)$$

To supply this level of consumption  $T_{rs}^M \cdot m_s(j)$  units have to be shipped.

Summing across locations in which the product is sold, total sales of a single location  $r$  variety are given by,

$$q_r^M = m \sum_{s \in \mathcal{S}} Y_s (p_r^M T_{rs}^M)^{-s} G_s^{s-1} T_{rs}^M \quad (12)$$

We can now turn to the producer behavior.

The production of any variety of manufactured good involves a fixed cost and a constant marginal cost giving rise to economies of scale:

$$l^M = F + c^M q^M \quad (13)$$

Because of increasing returns to scale, the preference for variety by consumers and the unlimited number of potential varieties of manufactured goods; each variety will be produced by a single, specialized firm.

The profit of a particular firm producing a specific variety at location  $r$  and facing a given wage rate for manufacturing workers,  $w_r^M$ , is given by,

$$\Pi_r = p_r^M q_r^M - w_r^M (F + c^M q_r^M) \quad (14)$$

Profit maximization implies that

$$p_r^M (1 - 1/s) = w_r^M c^M \quad (15)$$

$$\text{or } p_r^M = w_r^M c^M / \mathbf{r}$$

If there is free entry of firms into manufacturing, profits must be driven to zero.

Given the pricing rule, the profits of a firm at location  $r$  are:

$$\Pi_r = \frac{c^M w_r^M}{s-1} \left( q_r^M - \frac{F(s-1)}{c^M} \right) \quad (16)$$

The zero-profit condition implies that the equilibrium output of any firm is:

$$q_r^{M*} = \frac{F}{c^M} (s-1) \quad (17)$$

Output per firm is the same in each region.

The associated equilibrium labor input is also constant and given by,

$$l^* = F + c^M q^* = F\mathbf{S} \quad (18)$$

Then the number of manufacturing firms at location  $r$  is:

$$n_r = \frac{L_r^M}{l^*} = \frac{L_r^M}{F\mathbf{S}} \quad (19)$$

All scale effects work through changes in the variety of goods available.

The equilibrium output of any firm has to be equal to the demand for it, so:

$$q_r^{M*} = \mathbf{m} \cdot \sum_{s \in \mathbf{s}} Y_s (p_r^M)^{-s} (T_{rs}^M)^{1-s} G_s^{s-1} \quad (20)$$

With a little bit of algebra, we can obtain the manufacturing wage equation:

$$w_r^M = \left( \frac{\mathbf{S} - 1}{\mathbf{S} \cdot c^M} \right) \left( \frac{\mathbf{m}}{q^*} \sum_s Y_s (T_{rs}^M)^{1-s} G_s^{s-1} \right)^{1/s} \quad (21)$$

This equation gives the manufacturing wage at which firms in each location break even.

To obtain the real wage equation of location  $r$  manufacturing workers,  $w_r^M$  we have to deflate the nominal wage by the consumer price level  $G_{r\mu}(p_r^A)^{1-\mu}$ . We obtain:

$$\mathbf{w}^M = w_r^M G_r^{-m} (p_r^A)^{-(1-m)} \quad (22)$$

We can simplify the manufacturing price index and the wage equation choosing units of measurement.

First we choose units for output such that the marginal labor requirement satisfies the following equation:

$$c^M = \frac{\mathbf{S} - 1}{\mathbf{S}} = \mathbf{r} \quad (23)$$

Then the pricing equation, (15), becomes

$$p_r^M = w_r^M \quad (24)$$

Next we set the fixed input requirement  $F$  to satisfy the following equation:

$$F = \frac{\mathbf{m}}{\mathbf{s}} \quad (25)$$

The equilibrium labor input, (18), now becomes:

$$l^* = F \cdot \mathbf{s} = \mathbf{m} \quad (26)$$

And therefore the number of manufacturing firms in each location given by equation (19) is now:

$$n_r = \frac{L_r^M}{\mathbf{m}} \quad (27)$$

We can then, simplify the price index and wage equations.

The price index equation, (10), becomes:

$$G_r = \left[ \frac{1}{\mathbf{m}} \sum_s L_s^M (w_s T_{sr}^M)^{(1-s)} \right]^{\frac{1}{1-s}} \quad (28)$$

And the wage equation, (21), can now be written as:

$$w_r^M = \left[ \sum_s Y_s (T_{rs}^M)^{1-s} G_s^{s-1} \right]^{\frac{1}{s}} \quad (29)$$

There are three regions in the economy. There are two factors of production in each region, peasants and workers. Each factor is assumed specific to one sector. Peasants produce agricultural goods in a perfectly competitive fashion. The peasant population is assumed completely immobile between regions. Workers produce manufactured goods and can move freely between the two domestic regions but not to the external region.

We shall choose units so that world manufacturing labor force is  $L^M = \mu$  and world agricultural force is  $L^A = 1 - \mu$

In each region the share of labor force devoted to manufacture is  $\mathbf{m}$ , the expenditure share of manufactured goods, with a share  $I_0$  in location 0,  $I_1$  in location 1

and  $\lambda_2$  in location 2. Workers are not allowed to move to and from the external region 0 so we assume  $I_0$  is constant at any point in time.

Agriculture is evenly divided between the three regions so that:

$$L_0^A = L_1^A = L_2^A = (1 - m)/3$$

Agricultural goods can be freely transported and are produced with constant returns so agricultural workers will have the same wage rate in all regions. We use this wage rate as the numeraire, so  $w^A = 1$ .

The incomes of the three regions can then be written:

$$Y_0 = w_0 \cdot I_0 \cdot m + \frac{1 - m}{3} \quad (30)$$

$$Y_1 = w_1 \cdot I_1 \cdot m + \frac{1 - m}{3} \quad (31)$$

$$Y_2 = w_2 \cdot I_2 \cdot m + \frac{1 - m}{3} \quad (32)$$

And the price index equations,

$$G_0 = \left[ I_0 \cdot w_0^{(1-s)} + I_1 \cdot (w_1 T_0)^{1-s} + I_2 (w_2 T_0)^{1-s} \right]^{\frac{1}{1-s}} \quad (33)$$

$$G_1 = \left[ I_0 \cdot (w_0 \cdot T_0)^{1-s} + I_1 \cdot (w_1)^{1-s} + I_2 \cdot (w_2 T)^{1-s} \right]^{\frac{1}{1-s}} \quad (34)$$

$$G_2 = \left[ I_0 \cdot (w_0 T_0)^{1-s} + I_1 (w_1 T)^{1-s} + I_2 \cdot w_2^{1-s} \right]^{\frac{1}{1-s}} \quad (35)$$

These price index equations have a crucial property. Price index in any of the domestic Regions, 1 or 2, will tend to be lower, the higher the share of manufacturing that is in the region, the lower the share of manufacturing in the other domestic region. So a shift of manufacturing into one of the regions will tend other things equal to lower the price index

in that region and thus make the region a more attractive place for manufacturing workers to be. This is a form of “forward linkage” or cost effect that tends to reinforce an unequal geography. This effect is entirely due to internal transport costs. As we are assuming  $I_0$  constant (non labor mobility with the external region), it’s the existence of transport costs between the two domestic regions that produce this forward linkage.

The wage equations for the three regions are:

$$w_0 = \left[ Y_0 G_0^{s-1} + Y_1 T_0^{1-s} G_1^{s-1} + Y_2 T_0^{1-s} G_2^{s-1} \right]^{\frac{1}{s}} \quad (36)$$

$$w_1 = \left[ Y_0 T_0^{1-s} G_0^{s-1} + Y_1 G_1^{s-1} + Y_2 T_1^{1-s} G_2^{s-1} \right]^{\frac{1}{s}} \quad (37)$$

$$w_2 = \left[ Y_0 T_0^{1-s} G_0^{s-1} + Y_1 T_1^{1-s} G_1^{s-1} + Y_2 G_2^{s-1} \right]^{\frac{1}{s}} \quad (38)$$

Like the price index equations, the wage equations also exhibit an important property. If price indexes in all regions were similar, then the nominal wage rate in a region will tend to be higher if incomes in this region or in other regions with low transport costs from this region are high. If internal transport costs,  $T$ , are lower than external transport costs,  $T_0$ , that would mean that nominal wage rate in a domestic region would be higher, the higher income in the national economy as a whole but specially the higher income in this particular region. The reason is that firms can afford to pay higher wages if they have good access to a larger market. This is thus a form of “backward linkage” or demand effect that reinforces the forward linkage analyzed before.

And finally, the real wage equations are the following:

$$w_0 = w_0 G_0^{-m} \quad (39)$$

$$w_1 = w_1 G_1^{-m} \quad (40)$$

$$w_2 = w_2 G_2^{-m} \quad (41)$$

In this model the distribution of manufacturing across regions is given at any point in time by the simultaneous solution of these 12 equations.

Over time workers can move between the two domestic regions. We assume that  $\lambda$ , the regional allocation of manufacturing labor, adjusts according to the real wage difference  $\omega_1 - \omega_2$  in the following fashion:

$$\lambda = \gamma (\omega_1 - \omega_2) \quad (42)$$

The model is too complicated to be solved analytically so we are limited to look at some numerical examples to see possible results of the dynamics over time.

We plot  $\omega_1 - \omega_2$ , the difference between the two domestic regions real wage rates in manufacturing, against  $\lambda_1$ , region 1 share of manufacturing. Any point where the wage differential is 0 is an equilibrium; such an equilibrium is stable if the schedule is downward-sloping, unstable if it is upward-sloping. There may also be corner equilibria: if all labor is concentrated in location 1, it will stay there if  $\omega_1 > \omega_2$ , and conversely.

We assume  $\sigma = 6$ ,  $\mu = 0.4$ ,  $T = 1.75$  and  $\lambda_0 = 1/3$ . We are not making the external region too large so as to distort our results. Mark-up estimates are normally between 10% and 30% (Bresnahan, 1989). To these mark-up values correspond an elasticity of substitution  $\sigma$  between 10 and 4. In what concerns the share of labor in industry, percentages around 40% are reasonable for developed regions.

We let the external transport cost  $T_0$  take three different values corresponding to three different cases, the high-transport case, the intermediate-transport case and the low-transport case. This will allow us to analyze how the integration of the domestic economy with the outside world, as measured by the cost  $T_0$ , will affect the equilibrium allocation of labor between the two domestic regions.



These three different cases are shown in Figs1-3.

In Fig.1, we have  $T_0=1.9$ . The wage differential is positive if  $\lambda_1$  is less than  $1/3$ , negative if  $\lambda_1$  is greater than  $1/3$ . If a region has more than a third of the world manufacturing labor force it is less attractive to workers than the other region. In this case the economy converges to a long run symmetric equilibrium in which manufacturing is equally divided between the two domestic regions.

In Fig.2, we show what happens when the economy is opened slightly,  $T_0=1.4$ . The equilibrium in which manufacturing population is evenly distributed between the two domestic regions each of them having one third of world manufacturing population, is still stable. Concentration of population in either region is, however, stable, as well. There are two other unstable equilibria that lie between the stable equilibria. If  $\lambda_1$  starts from either a sufficiently high or a sufficiently low initial value, the economy will converge not to the symmetric equilibrium but to a core-periphery pattern with all manufacturing in only one region. There are five equilibria, three stable (the symmetric equilibrium and manufacturing concentration in either region) and two unstable.

Finally, when the economy is opened further,  $T_0=1.3$ , the symmetric equilibrium becomes unstable and the only stable allocations are concentration in one region or the other.

Fig 4. shows how the types of equilibria vary with external transport costs. Solid lines indicate stable equilibria, broken lines unstable.

At high external transport costs, there is a unique stable equilibrium in which manufacturing is evenly divided between the two domestic regions. When external transport costs fall below some critical level ( $T(S)$ , the sustain point), a core-periphery equilibrium in which all manufacturing is concentrated in one of the two domestic regions becomes possible although the symmetric equilibrium is still stable. When the economy is opened further, and external transport costs fall below a second critical level ( $T(B)$ , the break point), the symmetric equilibrium becomes unstable and so the domestic economy must necessarily show a core-periphery pattern with all manufacturing concentrated in one region.

Break and sustain points depend on some of the parameters in the model. This dependence is summarized in table 1 which reports the break point and the sustain point at different values of  $\mu$  and  $\sigma$ .

	$\mu=0.38$	$\mu=0.40$	$\mu=0.42$
$\sigma=5$	$T(B)=1.7$ No sustain point	$T(B)=1.9$ No sustain point	$T(B)=2.2$ No sustain point
$\sigma=6$	$T(B)=1.28$ $T(S)=1.35$	$T(B)=1.35$ $T(S)=1.45$	$T(B)=1.4$ $T(S)=1.6$
$\sigma=7$	$T(B)=1.162$ $T(S)=1.165$	$T(B)=1.20$ $T(S)=1.22$	$T(B)=1.24$ $T(S)=1.28$

The sustain point always occurs at a higher value of  $T_0$  than does the break point. Both critical values are increasing in  $\mu$ , so the range of transport costs in which the core-

periphery pattern occurs is greater the larger is the share of manufactures in the economy. The manufacturing sector can then generate forward linkages via supply and backward linkages via demand which constitute centripetal forces that allow to sustain a core-periphery equilibrium over a wide range of transport costs. Both critical values are decreasing in  $\sigma$ , so the range of transport costs in which the core-periphery pattern occurs is greater the smaller is the elasticity of substitution among products (the more differentiated are the products). If  $\sigma$  decreases then the number of varieties produced at a location increases and firm's price cost mark-ups decrease. Scale effects are thus stronger the smaller is the elasticity of substitution between varieties and therefore the range of transport costs at which the core-periphery equilibrium occurs is larger. Centripetal forces in the model are a combination of economies of scale, market size and transport costs. By decreasing  $\sigma$ , we are increasing the magnitude of scale economies.

## Conclusions

The results of our theoretical exercise seem to prove that protectionist policies are not necessarily responsible for the settlement of a pattern of regional inequalities. In fact, in our model it's the opening up of a closed economy that brings further regional polarization.

This result is consistent with the interruption in the regional convergence process observed in the European Union since the 80's (Esteban 1994). This interruption is specially remarkable in the Spanish case and parallels the entry of Spain in the EC (1986) and its reception of cohesion funds.

The result is opposite to that of Krugman-Livas (1996) which used as the centrifugal force in their model not the pull of an agricultural population tied to the land but a congestion cost. In their case, trade liberalization brings deconcentration of economic activity. Their model could be suitable to describe a phenomenon of urban concentration like the growth of Mexico City's agglomeration, but ours seems more adequate to describe regional inequality processes.

Future research should focus in empirical work in order to validate the positive relationship between trade liberalization and industrial concentration predicted in our model.

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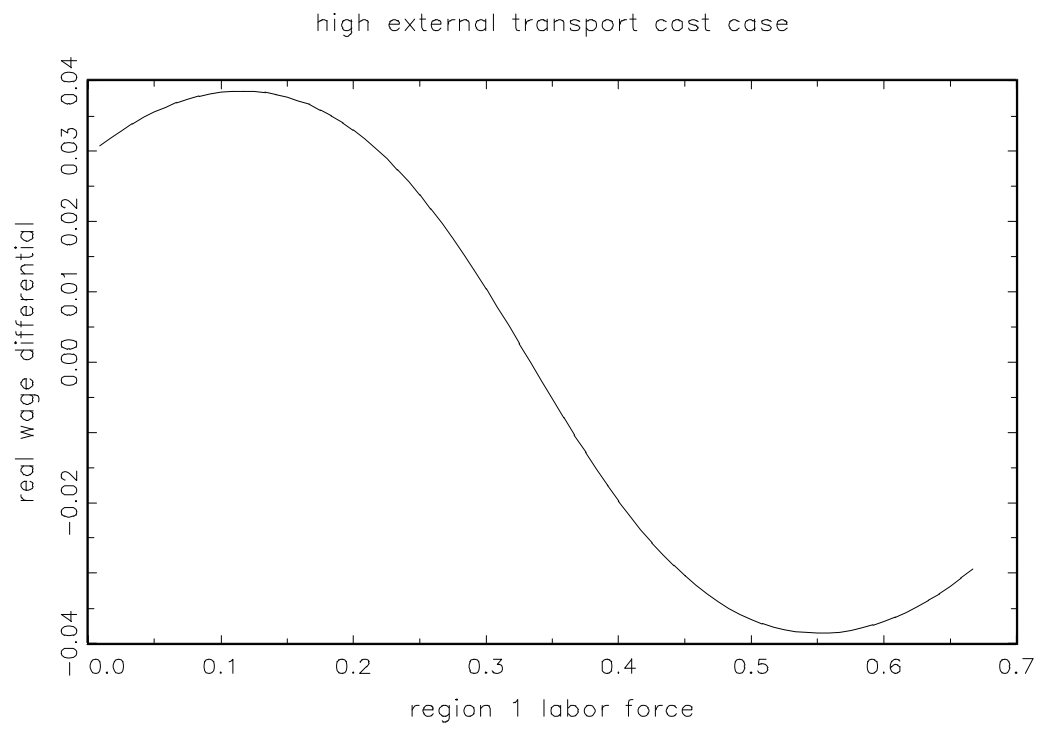
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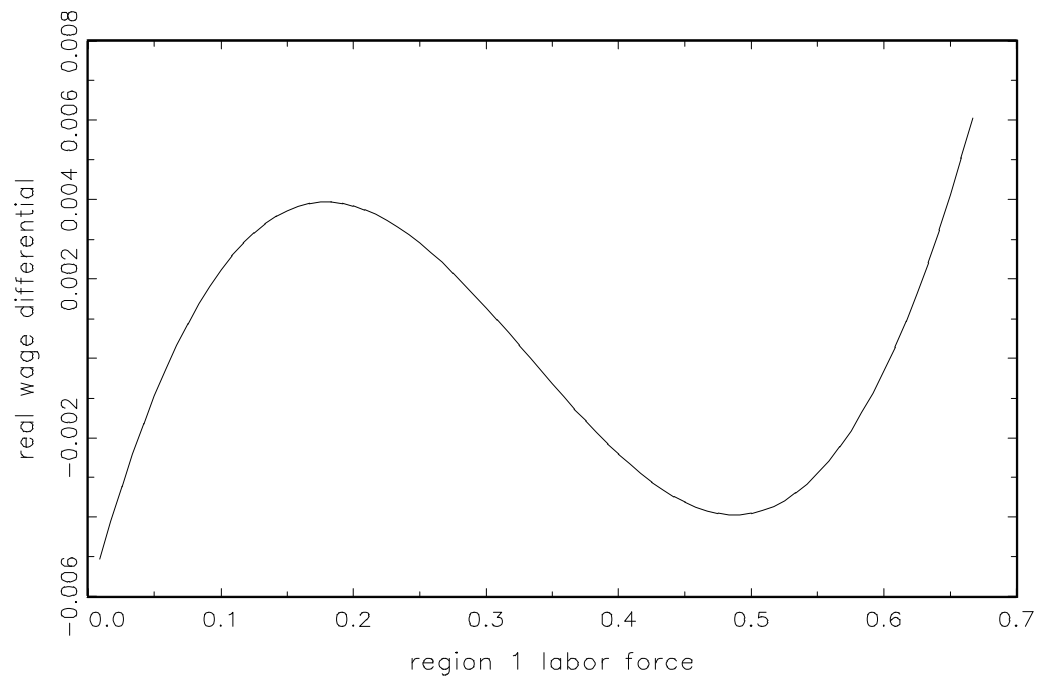
## APPENDIX

**FIG 1. Real wage differential  $\omega_1 - \omega_2$  against labour force in Region 1,  $T_0=1.9$**



**FIG 2. Real wage differential  $\omega_1 - \omega_2$  against labour force in Region 1,  $T_0=1.4$**

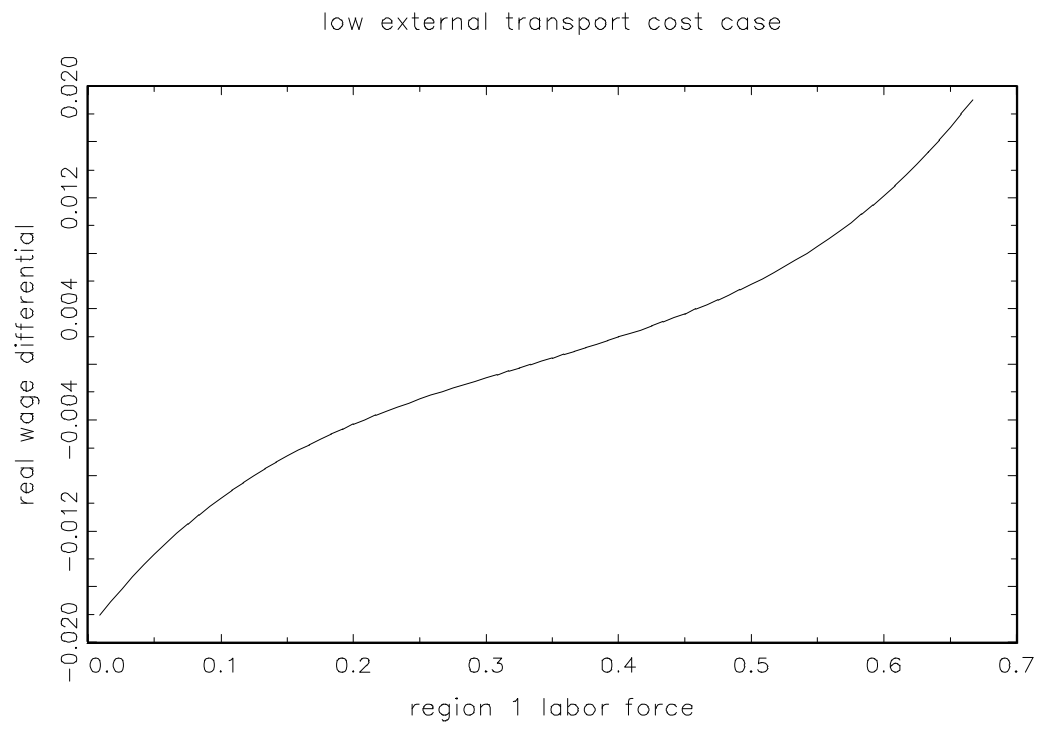
intermediate external transport cost case





**FIG 3. Real wage differential  $\omega_1 - \omega_2$  against labour force in Region 1,  $T_0=1.3$**

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**FIG 4. Equilibria and external transport costs**

