Regional Integration and Internal Economic Geography - an Empirical Evaluation with Portuguese Data[1]

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Abstract: The effects of the reduction of international trade costs on the internal economic geography of each country have been very scarcely studied in empirical terms. With data for Portugal since its adhesion to the European Union, we test the hypotheses put forward by the new economic geography concerning the evolution of the spatial concentration of the manufacturing industry as a whole and of the different industries individually considered. We consider alternative concentration concepts and data disaggregated both at the level of NUTS III (28 regions) and *concelhos* (275 regions). Results show a dispersion of total industry as a consequence of the reduction of international trade costs, in line with Krugman and Elizondo (1996)'s prediction. Individual industries show a similar tendency, in contrast with the theoretical hypothesis.

Keywords: trade liberalization, industrial location, Portugal.

JEL Codes: F12, F15, R12

1. Introduction

Empirical work on the spatial dimension has attracted a vast interest in the last fifteen years in the context of the so-called new economic geography (NEG). A large number of studies on this topic have examined the impact of trade liberalization on the location of economic activity within integrated spaces, with special emphasis on the European Union (EU) case. Nevertheless, NEG also provides the adequate conceptual framework to evaluate the impact of trade liberalization on the internal economic geography of each member state. In particular, it allows to evaluate whether economic integration leads either to internal structural convergence or to divergence, thus contributing to the increase/decrease of internal economic cohesion.

Surprisingly, however, the empirical evidence on this internal spatial dimension is very scarce and far from conclusive. Considering the Portuguese case, we aim to fill this gap in the literature.

Relative to previous studies, we consider additional concepts of spatial concentration and a wider set of indices as well as a much more disaggregated data at the regional level. Furthermore, the database used covers the period since the Portuguese adhesion to the EU (January 1986) and, therefore, it is particularly adequate for the purpose of this paper.

The fact that Portugal is the EU member which depends most strongly on the EU market (both with regard to exports and imports) gives a particular interest to this country case.

The paper is organized as follows. In section 2, we present the theoretical arguments concerning the impact of trade liberalization on the relocation of economic activity at the country level. In section 3, we analyze the results of the empirical evidence previously produced on this question. In section 4, we describe the data and discuss the different methodologies which will be used in the empirical evaluation of the Portuguese case developed in section 5. Finally, in section 6, we present some concluding remarks.

2. Theoretical guidelines

In a pioneering study on this topic, Krugman and Elizondo (1996) posit the existence of a positive relationship between international trade costs and the degree of spatial concentration of manufacturing industry as a whole.[2] Inspired by the Mexican case, their model explains the growth of the giant Third Model metropolis (as is the case of Mexico City) as a consequence of strong forward and backward linkages that emerge when manufacturing industry tries to serve a closed domestic market. With trade liberalization, these linkages are weakened and there is an incentive to the dispersion of economic activity within the country.

To formalize the above mentioned relation, Krugman and Elizondo (1996) employ an NEG model comprising three regions: two internal ones, which we designate as 1 and 2, and an external one, representing the rest of the world, which we designate as 0. Models of economic geography always incorporate the tension between a centripetal force that fosters spatial concentration and a centrifugal force which encourages dispersion of economic activity. In this model, the centripetal force is represented by backward and forward linkages and the centrifugal force is

[2] See also Krugman (1996).

expressed by congestion costs resulting from the dimension of the region, specifically related to commuting costs and land rents.

Labor is perfectly mobile between 1 and 2, but not between these regions and 0 and, in each region, production takes place at a single central point. There are iceberg transport costs both between the internal regions (which we designate as τ) and between the latter and 0, the transport costs from any of these regions to 0 being equal ($\eta_{1,0} = \eta_{2,0}$). The two types of transport costs are distinct not only in their value but also in their own nature. While τ represents the internal distance and the infra-structures quality, as in Krugman (1996), η also includes trade barriers.

The impact of trade liberalization on the internal economic geography is investigated by giving different values to η. If η is very high, there will not be international trade and therefore, 0 does not affect the internal distribution of the economic activity. In this case, firms tend to locate close to each other in order to have an easier access to intermediate inputs. The increase in labor demand generates a wage increase, thereby attracting more workers and augmenting the dimension of the domestic market. This process makes this location more attractive to other firms which want to locate nearer to the final demand. The agglomeration process will cease when this positive effect is offset by the increase of congestion costs.

If η decreases significantly, the centripetal force becomes less important, because as firms become more dependent on the external market, the advantage associated with the proximity to final demand and to domestic suppliers of inputs becomes less relevant. As a result, there is an incentive for firms to move away from the more congested internal region (where the centrifugal force is stronger) to the other region, where they can pay lower wages.

Through numerical simulations, Krugman and Elizondo (1996) verify that with an intermediate value for η there are several stable equilibria: a symmetric equilibrium in which the manufacturing industry is evenly divided between the two domestic regions or, alternatively, the concentration in one of the regions. However, when η is low enough, the only stable equilibrium is the symmetric distribution.

The main conclusion of Krugman and Elizondo's (1996) model is thus clear: it is expected that the trade liberalization process will lead to the dispersion of the total industry within the country.[3] We designate this hypothesis as [H1].

An alternative view is proposed, for instance, by Paluzie (2001).[4] The main difference between the two models is the consideration of different centrifugal forces. In Paluzie (2001), it is given by the pull of a dispersed rural market, as in the standard model of Krugman (1991). Labor mobility between regions generates unequal geography within a country and it is shown, through numerical simulations, that trade liberalization reinforces this effect. In fact, while for a high value for η, the symmetric distribution between the two domestic regions prevails as equilibrium, the consideration of a low value for η leads to a core-periphery pattern, with all manufacturing industry concentrated in just one region. Paluzie (2001)'s conclusion is, therefore, opposite to that obtained by Krugman and Elizondo (1996): a reduction of international trade costs causes the concentration of total industry. We designate this hypothesis as [H1'].

Until now, we have focused on the effect of the reduction of international trade costs on the location of total industry. However, the changing pattern of industrial

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[3] For a critical perspective on this theoretical approach, see Isserman (1996) and Henderson (1996).

[4] See also Monfort and Nicolini (2000), Monfort and van Ypersele (2003), Crozet and Koenig-Soubeyran (2004a,b) and Brülhart et al. (2004).

location may not be uniform across industries. Fujita et al. (1999, chapter 18) show that trade liberalization may bring spatial clustering of particular industries and, therefore, regional specialization. In their model, the main centripetal force is given by backward and forward linkages while, more in line with the standard NEG model, the centrifugal force arises from final consumer demand in each location.[5] With the reduction of η, both forces are weakened. The openness to international trade leads the domestic firms to use a higher proportion of imported intermediate inputs and to sell a higher proportion of their own production in the foreign market and encourages the consumers to include a higher proportion of imports in their consumption. However, through numerical simulations, Fujita et al (1999) observe that the centripetal force prevails and, therefore, the specialization level of the regions tends to rise. We designate this hypothesis as [H2].

3. A brief survey of empirical evidence

The fact that contradictory theoretical predictions may be derived with regard to the impact of international trade costs reduction on the internal economic geography of the countries makes the role of empirical evaluation of this topic even more relevant. This section surveys the (still scarce) evidence produced so far in this area.

The most comprehensive study in terms of number of countries covered is that of Ades and Glaeser (1995). With a sample of 85 countries and data for 1970, 1975, 1980 and 1985, they verify that an increase of 10% of the trade share in GDP leads to a reduction of 6% in the size of the largest city, whereas an increase of 1% in the ratio of import duties to total imports implies an increase of almost 3% in the size of the

[5] Or, in some specifications, from immobile factors.

largest city. Nevertheless, Nitsch (2001, 2003) contested the robustness of this negative relation. For instance, considering different proxies for the degree of spatial concentration and the degree of openness, a causal link between openness and concentration is no longer observed either with Ades and Glaeser's (1995) database or in the case of other periods and groups of countries.

Other studies have concentrated their analysis on a specific country. The Mexican case has been one of the most profusely analyzed. The size of Mexico City, in addition to the adhesion of Mexico to NAFTA, makes this case particularly appropriate for the testing of the theoretical hypotheses of section 2. Results suggest that the removal of trade barriers initiated in the mid-1980s have contributed to the decentralization of Mexican industry away from Mexico City, as shown, for instance, by Krugman and Hanson (1993) and Hanson (1998). More recently, Arias (2003) confirmed the existence of a dispersion movement evaluated in terms of employment and production. In fact, in terms of employment, the share of total industry located in the three largest Mexican cities decreased from 56.4%, in 1975, to 45.0%, in 1985, and 37.6%, in 1993. These results suggest, however, that the dispersion movement was already visible between 1975 and 1985, increasing in the period 1985-1993, which points to the need for additional explanation.

De Robertis (2001) has analyzed the Italian case. With employment data in the period 1971-91 for 20 regions, the author confirms [H1]. Using De Robertis' (2001) data, we have calculated the absolute Gini index - designated below as $G^{(A)}$ - for total manufacturing industry, obtaining values of 0.632, in 1971, and 0.596, in 1991, thus reinforcing the evidence of the decrease of the absolute spatial concentration.[6]

[6] The same conclusion emerges from the study of Chakravorty (2003).

Some analysis on [H2] has also been conducted for several countries, but in general it has not been possible to draw a clarifying conclusion. In a pioneering study on this topic, Hanson (1998) analyzes the Mexican case but the evidence obtained is mixed. In De Robertis' (2001) study on Italy, results are contradictory, depending on the industry analyzed, with the sharpest increase in geographical concentration registered by the textile and clothing industries, whereas the transport sector shows the most significant opposite tendency.

Paluzie et al. (2001) present some evidence for Spain between 1979 and 1992. The results, however, do not provide a clear confirmation of [H2] in the case of the Spanish NUTS III regions. In fact, only 16 of the 50 regions considered show an increase of specialization while, in terms of sectoral location, only 13 of the 30 sectors show an increase in their level of spatial concentration. Moreover, these changes are, on average, very moderate.[7]

To sum up, the existing studies, including those which concentrate on the European integration process, do not present straightforward evidence, thus reinforcing the importance of additional research in this field.

4. Measurement and data

Aiming to test the hypotheses formulated in Section 2, we consider statistical information for Portugal between 1985 and 2000. We use employment data at the 2-digit level of the *Classificação das Actividades Económicas* (CAE), revision 2, for

[7] The evaluation considers the Gini index. Although it seems to be the relative index (see next section), this is never made explicit.

manufacturing industry (sectors 15 to 37).[8] The data is from *Quadros de Pessoal* - Ministry of Employment.[9] In spatial terms, Portugal (excluding Madeira and Azores) consists of 5 NUTS II, 28 NUTS III and 275 *concelhos*. The two highest levels of disaggregation are used in this paper, aiming to test the robustness of the conclusions. Let us denote[10] by x_{ji} the employment in sector j (j = 1, 2, …, J) in region i (I = 1, 2, …, I) with J = 23 and I = 28 (in the case of the evaluation based on NUTS III) or 275 (in the case of the analysis based on *concelhos*).[11]

Based on the information of matrix X, we calculate, as an intermediate step to obtain spatial concentration indices, the matrix S, with generic element $s_{ji} = x_{ji}/x_j$ where x_j is the total employment in sector j. Thus, s_{ji} represents the share of region i in the locational distribution of j. We can also obtain matrix V, with generic element $v_{ji} = x_{ji}/x_i$ where x_i represents total employment in i. v_{ji} is, therefore, the share of sector j in the sectoral structure of i. V is, therefore, an intermediate step to obtain specialization indices.

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[8] At this level of aggregation, this nomenclature is fully compatible with NACE-Eurostat.

[9] Until 1994, the information is presented according to CAE - revision 1. Therefore, this information was converted into revision 2, in accordance with the conversion table between the two nomenclatures. In order to minimize the problems associated with the conversion, statistical information until 1994 is initially considered at the highest level of disaggregation and then converted to the 2-digit level of revision 2.

[10] For the sake of simplicity, we omit the time notation.

[11] Since 1999, there have been 278 *concelhos*. In order to assure compatibility, we affect the values of x_{ji} of the three new *concelhos* to those of which ones they were previously part, taking the area as weight. Only in one case is it necessary to follow this procedure. In the two other cases, each new *concelho* is originated entirely in only one *concelho*, for which reason the conversion is immediate.

Aiming to obtain as comprehensive a vision as possible of industrial relocation originated by the reduction of international trade costs, we use four alternative concentration concepts: absolute, relative, topographic and geographical.

The concept of absolute spatial concentration only takes into consideration the distribution of the sector in question by the different regions. Spatial concentration of j will be the maximum when this sector is totally concentrated in only one region and the minimum when it is distributed equally among all regions. We consider two alternative indices of absolute concentration. The first is the commonly used Gini index ($G_j^{(A)}$). Its calculation implies the following procedure: (i) to rank the values of s_{ji} in an increasing order, designating them by $a_{j(h)}$ with h (h = 1,2, …, I) indicating the order; (ii) to obtain the partial accumulated values $d_{j(h)}$ such that $d_{j(1)} = a_{j(1)}$, $d_{j(2)} = d_{j(1)} + a_{j(2)}$, …, $d_{j(I)} = d_{j(I-1)} + a_{j(h)}$; (iii) to define $c_{j(h)} = (h/I)$. The absolute Gini index is given by:

$$G_j^{(A)} = 1 - \left[\left(\sum_{h=1}^{I-1} d_{j(h)} \right) / \left(\sum_{h=1}^{I-1} c_{j(h)} \right) \right] \quad ; G_j^{(A)} \in [0\ ,\ 1] \qquad [1]$$

Alternatively, we consider a new index which quantifies the deviations between the effective locational distribution of j and a hypothetical equal distribution among all regions. Taking the location coefficient as reference, it is expressed as follows:

$$E_j^{(A)} = \sum_{i=1}^{I} \left| s_{ji} - 1/I \right| \ ; E_j^{(A)} \in [0, (2I - 2)/I] \qquad [2]$$

Both indices increase with the degree of absolute concentration of the locational distribution of j.

In respect of the relative indices, they compare the locational distribution of j with the distribution of a sector assumed as reference. As usually in these evaluations, we use as reference "sector" the manufacturing industry as a whole (which we designate as q) and, as such, we use this concept only in the evaluation of [H2]. The first relative indicator used is the location coefficient, which can be expressed as:

$$E_j = \beta \sum_{i=1}^{I} | s_{ji} - s_{qi} | \ ; E_j \in [0 , 2 \beta[\qquad [3]$$

In the most common case, $\beta = ½$ and, therefore, E_j ranges between 0 and 1, increasing with the degree of dissimilarity between the two distributions considered.[12]

With regard to the relative Gini index it is obtained with the following procedure: (i) considering the values of the location quotient ($LQ_{ji} = s_{ji}/s_{qi}$) and the corresponding values of s_{ji} and s_{qi} and ranking them in increasing order of LQ_{ji}; (ii) designating the values of LQ_{ji}, s_{ji} and s_{qi} ranked this way respectively by $a_{j(h)}$, $b_{j(h)}$ and $e_{q(h)}$ with h (h = 1, 2, …, I) representing the order; (iii) calculating the partial accumulated values $g_{j(h)}$ such that $g_{j(1)} = b_{j(1)}$, $g_{j(2)} = g_{j(1)} + b_{j(2)}$, …, $g_{j(I)} = g_{j(I-1)} + b_{j(I)}$; (iv) calculating the partial accumulated values $m_{q(h)}$ such that $m_{q(1)} = e_{q(1)}$, $m_{q(2)} = m_{q(1)} + e_{q(2)}$, …, $m_{q(I)} = m_{q(I-1)} + e_{q(I)}$. The relative Gini index can be obtained as follows:

$$G_j^{(R)} = 1 - [(\sum_{h=1}^{I-1} g_{j(h)}) / (\sum_{h=1}^{I-1} m_{q(h)})] \ ; \ G_j^{(R)} \in [0 , 1] \qquad [4]$$

[12] When the "sector" of reference is the total industry, E_j never reaches 1.

$G_j^{(R)}$ takes value 0 when the distribution of s_{ji} is equal to s_{qi} and attains its maximum value when j totally concentrates in only one region.

The two concentration concepts analyzed until now correspond to what is commonly adopted in the empirical analysis. In the evaluation of absolute concentration, all regions are considered as equal, whereas in the analysis of relative concentration, the dimension of the regions has an economic character conferred by the importance of the economic activity as a whole located in the different regions. A complementary approach consists of considering the spatial dimension of the regions, evaluated by their area.[13] We designate this type of indicators as topographic indices.

To evaluate the level of topographic concentration, we propose an approach based on the adaptation of the relative indices.[14] Let us define the area of i as ψ_i. We calculate the share of the area of i in the total area, thus obtaining:

$$\varphi_i = \psi_i / \left(\sum_{i=1}^{I} \psi_i\right) \qquad [5]$$

The analysis of topographic concentration requires the comparison of the locational structure of j with the one inherent to the values of φ_i. Using the location coefficient as reference (with $\beta = ½$), the degree of topographic concentration of j can be measured as follows:

[13] The importance of this concept is greater if the dimensional dissimilarity between the regions is significant. In the present case, the area of the Portuguese *concelhos* ranges from 7.97 Km^2 (São João da Madeira) to 1721.42 Km^2 (Odemira).

[14] For an alternative perspective, see Brülhart and Traeger (2003).

$$TOP_j = \frac{1}{2} \sum_{i=1}^{I} | s_{ji} - \varphi_i | \; ; \; TOP_j \in [0 , 1[\qquad [6]$$

The minimum value of the admissible range corresponds to a uniform distribution of j, i.e. when each region has a proportion of j equal to its share in terms of area.[15] Any divergence facing this situation leads to an increase of topographic concentration. Top_j assumes its maximum value, converging to 1, when all the activity of j is located in the smallest region.[16]

The indices that we have considered thus far ignore the geographical position of the regions, i.e. they do not consider inter-regional distances. Nevertheless, it is also important that the analysis of the locational concentration investigates if the concentration occurs in nearby or distant regions. In order to control this factor, Midelfart-Knarvik et al. (2000, 2002) propose an index of geographical separation. However, this index does not consider the internal dimension of the regions, taking the value 0 if j is fully concentrated in only one region, whatever it is. To overcome this weakness, we propose an amplified version of this geographical index by incorporating the intra-regional dimension. It is expressed as follows:

$$GL_j = \gamma \sum_{i=1}^{I} \sum_{k=1}^{K} (s_{ji} \, s_{jk} \, \delta_{ik}) \; ; \; GL_j \;]0 , +\infty[\qquad [7]$$

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[15] Obviously, a uniform intra-regional distribution is assumed. Therefore, the real topographic concentration is sub-evaluated. The solution to this problem can only be attained by using very detailed geographical information. The development of more sophisticated indices considering this type of information is an interesting research topic. On this question, see Brülhart and Traeger (2003).

[16] Top_j never reaches 1 since that would mean that all the activity of j is located in a region with area equal to zero.

where γ is a constant[17] and δ_{ik} represents the distance between i and k.

Following Keeble et al. (1988) and Brülhart (2001), we use the expression $\delta_{ii} = 1/3 (\psi_i /\pi)^{1/2}$ to calculate intra-regional distances.[18] A rigorous use of this latter index requires geographically detailed data. Therefore, we confine its application to the case of the spatial dissagregation by *concelhos*. The calculation of GL_j requires the consideration of the bilateral distances between all the *concelhos* (75350 inter-regional and 275 intra-regional distances). These distances are obtained from the program ROUTE 66. We considered two ways of calculating distances: one in kilometers - GL(km.) - and another which estimates the time (in minutes) needed to travel that distance by car, taking into consideration the characteristics of the different roads (based on speeds pre-defined by the program) - GL(min.).

Table 1 summarizes the four concentration concepts used in this paper to evaluate the level of locational concentration of a given sector j.

[Insert Table 1 here]

[17] We assume γ=1.

[18] As a result of an intense debate on this question, particularly in the context of the "border effects" literature, there is, nowadays, a wide range of measures of intra-regional distances. For a survey on this question, see Head and Mayer (2002).

5. Empirical evidence for the Portuguese case

5.1. Evidence on total industry

As was observed in section 2, based on Krugman and Elizondo (1996), the dispersion of the total manufacturing industry can be expected to take place as a consequence of trade liberalization, with a reduction of the share of the total economic activity located in the regions initially more congested. The opposite movement is predicted, for instance, by Paluzie (2001).

A first way of evaluating this question consists of verifying whether the locational structure of the total industry has changed significantly during the period analyzed. With this objective, we use the Lawrence index which allows us to compare the level of similarity of the locational structures of a given sector in two different years. Designating it by T_j it is expressed as follows:

$$T_j = \tfrac{1}{2} \sum_{i=1}^{I} | s_{ji00} - s_{ji85} | \ ; T_j \in [0 , 1] \qquad [8]$$

T_j ranges between 0 and 1, increasing with the transformation level of the locational distribution of j. Table 2 presents the results concerning manufacturing industry as a whole, between 1985 and 2000.

[Insert Table 2 here]

The evidence presented in Table 2 suggests a significant transformation in the spatial distribution of the total industry by the Portuguese NUTS III (T = 0.178), more remarkable in the sub-period 1990-1995. In an annual evaluation, one verifies that it is in the post-Single Market period that the locational transformation is the strongest, particularly, by decreasing order, between 1995-1996, 1996-1997 and 1993-1994. The replication of this analysis by *concelhos* points to a clear similitude of conclusions. Once again, the transformation of the locational distribution is higher in the three mentioned years.

Using the indices presented in section 4, we focus now more specifically on the evolution of the spatial concentration of total industry. Table 3 presents the results based on a spatial disaggregation at NUTS III level. Note that in this case we only use the absolute and the topographic indices since the geographical index requires information at the *concelhos* level and the relative index is adequate only for individual industries.

[Insert Table 3 here]

The evidence presented in Table 3 shows an evident decrease of absolute and topographic concentration between 1985 and 2000. In fact, according to all the indices considered, the maximum value is registered in 1985 and the minimum in 2000.

Turning now our attention to spatial disaggregation by *concelhos*, the results are presented in Table 4.

[Insert Table 4 here]

The results obtained with the different indices at this level of spatial disaggregation are also concordant and elucidating: there is a significant reduction of the degree of absolute and topographic concentration of total industry. In its turn, the analysis in terms of geographical concentration reveals a decrease of the geographical separation between the regions where the industry is located. In fact, GL (min.) decreases from 125,26, in 1985, to 123,75, in 2000.

A complementary picture to the previous results is provided in Table 5, which presents the distribution of total manufacturing industry by NUTS III.

[Insert Table 5 here]

It is interesting to observe that the two regions with the highest share of total manufacturing industry at the beginning of the period analyzed - Grande Lisboa (with 25.8%) and Grande Porto (with 19.4%) - register a very significant reduction of their share, more accentuated in the case of Grande Lisboa, which shows the most significant reduction among all the variations considered. Serra da Estrela, Península de Setúbal, Algarve and Cova da Beira also have a reduction in the share of total manufacturing industry located in those regions. Tâmega ((s_{qi00} - s_{qi85}) = 0,0445), Baixo Vouga and Cávado, all of them with a low share of total manufacturing industry, display the most relevant increases of their shares. This general tendency is confirmed by the correlation coefficient between s_{qi85} and (s_{qi00} - s_{qi85}). The value registered (- 0.752) reflects the reduction of the concentration in the initially more congested regions.

The replication of this analysis at the level of *concelhos* shows that, in 1985, the group of three *concelhos* with the highest proportion of manufacturing industry comprises Lisboa (17.2%), Porto (5.6%) and Guimarães (5.2%). At the end of the period, Guimarães (with a value similar to the one in 1985 - 5.3%) comes first in this hierarchy, reflecting a strongly accentuated reduction of the relative weight of Lisboa - which had only 3.9% of total industry in 2000 - and of Porto - with a share of 2.3% in 2000. The correlation coefficient between s_{qi85} and (s_{qi00} - s_{qi85}) at this spatial disaggregation level is - 0.814, confirming the result previously presented.

The global conclusion which emerges from the evidence presented in this section concerning the spatial distribution of total industry is a clear support for the hypothesis postulated by Krugman and Elizondo (1996) - [H1]. In fact, during the trade liberalization process that follows adhesion to the EU there is a clear dispersion of total industry in the internal Portuguese space and a very significant reduction of the share of manufacturing industry located in the initially more congested areas.

5.2. Evidence on individual industries

Having considered the evidence concerning the total industry, we focus now our attention on the behavior of the individual sectors, in order to test the validity of [H2].

Once again, we start with the analysis of the transformation of the locational distribution by using T_j. The results obtained are presented in Table 6.

[Insert Table 6 here]

In what concerns the locational distribution at NUTS III level, a significant transformation of the pattern of sectoral location is visible, mainly in sectors 27 (basic metals) and 32 (radio, television and communication equipment). Sectors 17 (textiles) and 18 (clothing) - which are predominant in the Portuguese economy - present intermediate levels of locational transformation, showing respectively, the 6th and

12th position in terms of spatial stability. In an evaluation by sub-periods, 14 sectors have their highest locational transformation between 1990 and 1995.

The conclusions of the analysis at the *concelhos* level are similar to those for the NUTS III with regard to the sectors with the sharpest locational transformation during the period studied. However, in this case, it is also important to mention sector 34 (motor vehicles), besides sectors 16 (tobacco) and 37 (recycling), which present a low weight in terms of total employment.

A relevant observation emerging from the results for T_j in annual terms, at both levels of disaggregation, is that locational transformation is more accentuated in the post-Single Market, suggesting that the results of other studies for the EU area which do not include this period may be misleading.

Turning next to the analysis of the evolution of the degree of concentration of the spatial structure of the different sectors, we use the indices proposed to represent the four concepts of concentration considered.

In order to reduce the vast volume of information that is obtained with calculations at the sectoral level, Table 7 indicates whether the sector registers a concentration increase (+) or a concentration decrease (-) in the period analyzed. The same purpose led us to select the commonly used Gini index ($G_j^{(A)}$) to capture absolute spatial concentration and the location coefficient (E_j) to express relative spatial concentration.

[Insert Table 7]

The main result that emerges from Table 7 is an obvious divergence between the conclusions derived, on the one hand, from the relative concentration index and, on the other hand, from the absolute and topographic concentration indices.[19]

Let us observe that in the analysis by NUTS III, 13 sectors reveal an increase of relative concentration (evaluated by E_j) while only 10 sectors show an opposite tendency. In turn, the analysis based on the absolute index tells us that only sector 19 registered an increase of concentration during the period studied. The topographic concentration index (Top_j) corroborates this latter tendency as, according to this index, only sectors 29 and 30 became more spatially concentrated.

This dichotomy of results is even more evident when we consider a disaggregation by *concelhos*. In fact, the absolute and topographic indices indicate that no sector increased its spatial concentration, whereas E_j signals an increase tendency in 17 cases.

As a test of robustness, we have calculated the relative Gini index ($G_j^{(R)}$) for the two spatial levels that have been used. The results obtained show a high consistency with the evidence generated by E_j.

How to explain the distinct message given by the different indices? A primary explanation appears to be related to the fact that the use of relative indices presupposes the stability of the region/sector taken as reference. Nevertheless, in the present case, we have observed a strong transformation of the spatial distribution of total manufacturing industry. Therefore, when the analysis for specific industries is based on relative indices, the dispersion of total industry causes an increase of the

[19] The interpretation of the geographical concentration index is more complex since its variation cannot be unequivocally comparable with a specific evolution in terms of the remaining concentration concepts.

value of the index, which, in fact, is not related to a locational transformation of the sector in question. Being so, it seems more appropriate to concentrate the evaluation on the absolute and topographic indices, as the application of relative indices does not seem to produce reliable conclusions whenever the spatial distribution of total industry is not stable in the period analyzed.

The main conclusion to retain from the previous evidence is, therefore, a clear rejection of the hypothesis formulated by the NEG literature with regard to individual industries.

An alternative way of analyzing [H2] consists of evaluating the evolution of the degree of similarity of the sectoral structures of the different regions. An increase of specialization of the regions will be expressed in a growing divergence between their sectoral structures. In order to evaluate this question, we calculate the specialization coefficient in bilateral terms between all the pairs of regions for each year and for the two levels of spatial disaggregation used. With the matrices containing this information, we obtain, for each level of disaggregation, the simple averages in each year, which give us an indication of the degree of similarity between the sectoral structures of the regions. Table 8 presents the results.

[Insert Table 8 here]

Noting that a decrease of the value of the index signals a convergence of the sectoral structures of the regions, the evidence presented in Table 8 clearly suggests that, in the period analyzed, sectoral structures became more similar. This result is valid both at the level of NUTS III and *concelhos*. In fact, only two NUTS III

(Cávado and Beira Interior Sul) and 66 *concelhos* display a movement of structural divergence between 1985 and 2000, evaluated in average bilateral terms.

The evolution of the degree of average bilateral similarity for each region (i.e. of that region compared with all the others) is, therefore, in line with the conclusion that emerges from the indices of absolute and topographic concentration presented above.

One may thus conclude that the theoretical prediction of an increase of the degree of specialization of the regions as a result of trade liberalization is not empirically confirmed in the Portuguese case.

6. Final remarks

The empirical evaluation of the impact of trade liberalization on the internal economic geography of each country is an important research topic which has been widely neglected. However, NEG offers the appropriate conceptual framework to study this question. The pioneering contribution of Krugman and Elizondo (1996) presents a model where the reduction of international trade costs causes a dispersion of manufacturing industry as a whole. However, other studies (for instance, Paluzie, 2001), making use of a distinct centrifugal force, reach an opposite conclusion. Concerning individual industries, Fujita et al. (1999, chapter 18) predict a spatial concentration movement and, therefore, an increase of the specialization level of the regions.

Considering different concepts of concentration and data for Portugal between 1985 and 2000, we evaluate both predictions. The results concerning industry as a whole confirm the hypothesis established by Krugman and Elizondo (1996), i.e. the dispersion of total industry. On the other hand, in relation to individual industries, the results differ according to the concentration concept adopted. Using the most appropriate concepts for this specific analysis (i.e., the absolute and topographic concentration), the results indicate the dispersion of the generality of the industries, in contrast to what had been predicted.

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Table 1 - Concepts of spatial concentration

Concentration concept	Question to evaluate	Maximum concentration	Minimum concentration
Absolute	Is sector j concentrated in many or few regions?	Sector j is in only one region	Sector j is evenly distributed by all regions
Relative	How similar are the spatial distributions of j and of the total economic activity?	Maximum divergence between the distributions of j and that of the total economic activity (where j is located, there are no other sectors)	The distribution of j is identical to that of total economic activity
Topographic	Is sector j uniformly distributed in the space?	Sector j is fully concentrated in the smallest region	Sector j has a spatial uniform distribution
Geographical	Is sector j located in close or distant regions?	Sector j is fully concentrated in the smallest region [(a)]	Sector j is equally distributed by the two regions which are the most distant from each other [(b)]

(a)Under the hypothesis that the internal distance of the smallest region is inferior to the shortest inter-regional distance; (b) Under the hypothesis that the longest inter-regional distance is superior to the internal distance of the largest region.

Table 2 - Structural transformation of the locational distribution of total industry, 1985-2000

Period	T (by NUTS III)	T (by *concelhos*)
1985/1990	0.065	0.095
1990/1995	0.084	0.112
1995/2000	0.047	0.081
1985/2000	0.178	0.241

Table 3 - Level of locational concentration of total manufacturing industry by NUTS III, 1985-2000

Years	$G^{(A)}$	$E^{(A)}$	Top
1985	0.693	0.514	0.683
1986	0.686	0.510	0.678
1987	0.682	0.510	0.680
1988	0.675	0.506	0.677
1989	0.676	0.508	0.680
1990	0.673	0.508	0.680
1991	0.659	0.496	0.671
1992	0.652	0.492	0.669
1993	0.643	0.483	0.662
1994	0.628	0.478	0.656
1995	0.623	0.473	0.654
1996	0.615	0.464	0.647
1997	0.611	0.466	0.648
1998	0.609	0.465	0.647
1999	0.608	0.464	0.647
2000	0.606	0.460	0.643

Table 4 - Level of locational concentration of total manufacturing industry by *concelhos*, 1985-2000

Years	$G^{(A)}$	$E^{(A)}$	Top	GL(km.)	GL(min.)
1985	0.829	0.674	0.752	188.34	125.26
1986	0.825	0.671	0.750	187.25	124.81
1987	0.824	0.669	0.750	186.19	124.29
1988	0.817	0.664	0.745	185.37	123.98
1989	0.817	0.664	0.747	184.01	123.19
1990	0.812	0.660	0.744	183.76	123.16
1991	0.803	0.651	0.736	184.41	123.87
1992	0.798	0.646	0.732	184.39	124.05
1993	0.791	0.638	0.726	184.44	124.27
1994	0.780	0.630	0.716	183.51	124.14
1995	0.777	0.625	0.714	184.17	124.59
1996	0.775	0.621	0.711	183.56	124.45
1997	0.765	0.611	0.702	181.92	123.67
1998	0.764	0.611	0.702	182.03	123.71
1999	0.761	0.609	0.703	183.21	124.33
2000	0.758	0.607	0.698	181.93	123.75

Table 5 - Share of each region in the locational distribution of total manufacturing industry (s_i), 1985-2000

NUTS III	1985	1990	1995	2000
Minho-Lima	0.0106	0.0129	0.0177	0.0206
Cávado	0.0370	0.0489	0.0607	0.0619
Ave	0.1259	0.1351	0.1326	0.1355
Grande Porto	0.1935	0.1929	0.1584	0.1476
Tâmega	0.0397	0.0597	0.0725	0.0842
Entre Douro e Vouga	0.0607	0.0657	0.0726	0.0722
Douro	0.0028	0.0029	0.0039	0.0042
Alto-Trás-os-Montes	0.0035	0.0035	0.0040	0.0042
Baixo Vouga	0.0449	0.0494	0.0599	0.0712
Baixo Mondego	0.0211	0.0208	0.0218	0.0213
Pinhal Litoral	0.0290	0.0304	0.0342	0.0383
Pinhal Interior Norte	0.0076	0.0099	0.0117	0.0122
Dão Lafões	0.0112	0.0137	0.0175	0.0209
Pinhal Interior Sul	0.0017	0.0020	0.0025	0.0027
Serra da Estrela	0.0069	0.0048	0.0051	0.0037
Beira Interior Norte	0.0040	0.0046	0.0056	0.0063
Beira Interior Sul	0.0043	0.0052	0.0056	0.0052
Cova da Beira	0.0130	0.0129	0.0134	0.0121
Oeste	0.0271	0.0300	0.0353	0.0355
Grande Lisboa	0.2582	0.2050	0.1580	0.1322
Península de Setúbal	0.0398	0.0373	0.0440	0.0384
Médio Tejo	0.0199	0.0160	0.0222	0.0213
Lezíria do Tejo	0.0138	0.0140	0.0148	0.0176
Alentejo Litoral	0.0023	0.0025	0.0034	0.0031
Alto Alentejo	0.0050	0.0049	0.0056	0.0063
Alentejo Central	0.0054	0.0056	0.0070	0.0105
Baixo Alentejo	0.0018	0.0016	0.0021	0.0023
Algarve	0.0093	0.0075	0.0079	0.0083

Table 6 - Transformation of the locational distribution of the manufacturing sectors (2 digit level), by NUTS III and *concelhos*, 1985-2000

Sectors	T_j (by NUTS III)				T_j (by *concelhos*)			
	85/90	90/95	95/00	85/00	85/90	90/95	95/00	85/00
15	0.042	0.104	0.065	0.162	0.123	0.176	0.142	0.270
16	0.162	0.162	0.001	0.001	0.162	0.162	1.000	1.000
17	0.052	0.102	0.058	0.188	0.072	0.124	0.094	0.228
18	0.118	0.103	0.066	0.273	0.159	0.135	0.106	0.320
19	0.083	0.065	0.048	0.150	0.132	0.107	0.096	0.249
20	0.061	0.067	0.061	0.125	0.127	0.159	0.103	0.247
21	0.110	0.230	0.099	0.331	0.131	0.295	0.169	0.460
22	0.040	0.038	0.038	0.099	0.101	0.113	0.094	0.253
23	0.000	0.023			0.000	0.023		
24	0.092	0.141	0.123	0.307	0.158	0.283	0.202	0.513
25	0.061	0.188	0.119	0.298	0.130	0.309	0.202	0.423
26	0.098	0.066	0.091	0.207	0.151	0.123	0.124	0.287
27	0.128	0.265	0.131	0.424	0.162	0.464	0.204	0.614
28	0.083	0.082	0.100	0.227	0.135	0.171	0.134	0.308
29	0.107	0.125	0.072	0.236	0.173	0.251	0.156	0.407
30	0.866	0.901			0.933	0.940		
31	0.108	0.294	0.329	0.305	0.269	0.379	0.383	0.558
32	0.078	0.223	0.282	0.482	0.090	0.460	0.379	0.566
33	0.174	0.136	0.100	0.247	0.228	0.217	0.158	0.355
34	0.126	0.310	0.278	0.296	0.168	0.404	0.472	0.644
35	0.088	0.179	0.112	0.325	0.132	0.332	0.203	0.563
36	0.070	0.077	0.065	0.195	0.117	0.134	0.094	0.253
37	0.147	0.595	0.527	0.389	0.234	0.757	0.707	0.719

Table 7 - Evolution of the levels of concentration by NUTS III and *concelhos*, 1985-2000

Sectors	by NUTS III			by *concelhos*			
	$G_j^{(A)}$	E_j	Top_j	$G_j^{(A)}$	E_j	Top_j	GL_j (min.)
15	-	+	-	-	+	-	+
16	-	+	-	-	+	-	-
17	-	-	-	-	+	-	-
18	-	+	-	-	+	-	-
19	+	-	-	-	-	-	-
20	-	-	-	-	-	-	-
21	-	-	-	-	-	-	+
22	-	+	-	-	+	-	+
23(a)	=	+	=	=	+	=	=
24	-	-	-	-	+	-	+
25	-	-	-	-	-	-	-
26	-	+	-	-	+	-	+
27	-	+	-	-	+	-	+
28	-	-	-	-	-	-	+
29	-	+	+	-	+	-	-
30(b)	-	+	+	-	+	-	+
31	-	-	-	-	+	-	-
32	-	+	-	-	+	-	+
33	-	-	-	-	+	-	+
34	-	+	-	-	+	-	+
35	-	+	-	-	+	-	+
36	-	+	-	-	+	-	-
37	-	-	-	-	-	-	+

(a) last year: 1999; (b) last year: 1997; + : concentration increase; - : concentration reduction

Table 8 - Average bilateral similarity by NUTS III and by *concelhos* - global average, 1985-2000

Years	by NUTSIII	by *concelhos*
1985	0.5454	0.6510
1986	0.5448	0.6482
1987	0.5428	0.6567
1988	0.5395	0.6552
1989	0.5304	0.6457
1990	0.5274	0.6541
1991	0.5228	0.6534
1992	0.5144	0.6411
1993	0.5070	0.6356
1994	0.5089	0.6361
1995	0.5137	0.6327
1996	0.5093	0.6360
1997	0.5124	0.6281
1998	0.5047	0.6250
1999	0.5023	0.6288
2000	0.4986	0.6145