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the Portuguese Case – an update***

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**Regional Integration and Internal Economic Geography in the
Portuguese Case – an update¹**

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Regional Integration and Internal Economic Geography in the Portuguese Case – an update

Abstract: The effects of the reduction of international trading 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 analyze 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 each individual sector. We use four alternative concentration concepts and data disaggregated both at the level of NUTS III (28 regions) and *concelhos* (275 regions). Results show a dispersion of manufacturing industry, in line with Krugman and Elizondo's (1996) prediction. Individual sectors show a similar tendency, in contrast with the theoretical hypothesis.

Keywords: trade liberalization, industrial location, Portugal.

JEL Codes: F12, F15, R12

1. Introduction

Analysis of the spatial location of economic activity has attracted a vast interest in the last fifteen years in the context of the so-called new economic geography (NEG), based on Krugman's (1991) pioneering model.² A large number of studies on this topic have examined the impact of decreasing cross-border trade barriers and transaction costs on the international distribution of manufacturing industry within integrated spaces, with special emphasis on the European Union (EU) space.³ This analysis may nevertheless mask relevant intra-national spatial effects of the location dynamics in the integrated economies (Storper et al., 2002), which have remained under-explored.

Two opposing territorial predictions can be found in the context of the NEG about the possible effects of trade openness on the internal distribution of manufacturing industry within a country: sectors either spread out in the country or, alternatively, they become more geographically concentrated. A natural interest of this type of analysis comes out by recognizing that concentrating economic activity may contribute to real divergence, i.e. divergence in real per-capita income levels⁴, while structural convergence is expected to help real convergence (Baldwin, 1999). In addition, it has a connection to regional policy by providing guidance for domestic adjustment policies aiming to face the variation of foreign market access across domestic regions.

This paper addresses the relation between trade liberalization and nationwide spatial adjustments of manufacturing industry in the case of Portugal after adhesion of this country to the EU in 1986. More precisely, we examine whether in the period 1985-2000 a stronger agglomeration of manufacturing industry or its gradual

dispersion occurred within the country and to what extent there is a link between trade openness and the observed pattern of industrial spatial adjustments. Both the manufacturing industry at the aggregate level (i.e. including all sectors) and each individual sector will be taken into consideration.⁵ Relative to previous studies, we consider additional concepts of spatial concentration as well as a much more disaggregated data at the regional level.

The period analyzed is particularly appropriate to the purpose of this paper, as the lapse of time since Portugal became a full member of the EU is sufficiently long to evaluate the spatial relocation of economic activity. Comparing to other similar studies for the EU members, another advantage of the period investigated is to include the post-Single Market, as it is characterized by a deep economic integration of the markets.

A motivation to study this country case is the fact that, in spite of the EU orientation of the Portuguese trade (with 68.0% of total exports and 58.9 % of total imports taking place with the EU market in 1986), the economy had remained rather closed to foreign trade until its entry into the EU, in contrast with a process of deep reduction of trade barriers undergone in the following period, and reinforced after 1992 with the cancellation of non-tariff barriers proposed by the Single Market.

In the wake of adhesion to the EU, not only tariffs on trade with EU members were removed, but also schemes of government authorization for imports, a surcharge on imports covering all trading partners as well as most quantitative restrictions, dropped in compliance with the accession rules. Besides, adaptation in respect of the EU's common external trade policy was largely expressed in an increasing openness with regard to products from non-EU countries, particularly in traditional sectors of specialization in the Portuguese economy, such as footwear and clothing.

The paper is organized as follows. Section 2 presents the theoretical background. Section 3 analyzes the results of previous empirical evidence on this topic. Section 4 describes the data and discusses the different methodologies which will be used in the empirical evaluation of the Portuguese case, developed in section 5. Section 6 discusses the possible impact of other factors besides cross-border trade liberalization on the observed intra-national spatial adjustments of Portuguese manufacturing industry. Section 7 presents some concluding remarks.

2. Trade openness and the internal economic geography of countries: theoretical guidelines

In the few existing NEG theoretical contributions related to the impact of falling trading costs on the internal geography of countries, opposing outcomes may be found. In a pioneering study on this topic, Krugman and Elizondo (1996) posit dispersion of manufacturing industry as a whole.⁶ Conversely, Paluzie (2001), based on Krugman's (1991) standard framework, shows that lower international trading costs is more likely to enhance agglomeration of manufacturing activity. Other extensions of Krugman's (1991) model with additional refinements, in general predict a result in line with that of Paluzie (2001). Nonetheless, it has been already shown that the relative development level of the trading countries (Alonso-Villar, 2001) and the way transport and trading costs are modeled (Mansori, 2003; Behrens, 2003; Behrens et al., 2003) might have a crucial impact on the results obtained.

A main explanation for the difference between predictions with respect to the implications of trade for regional inequalities has been related to the modelling of the tension between self-reinforcing centripetal forces producing agglomeration and

centrifugal forces that tend to weaken such agglomerations (Crozet and Soubeyran, 2004).

This argument is clearly illustrated when comparing Krugman and Elizondo's model (henceforth KE) with respect to Paluzie's. Both models consider a domestic country containing two regions, labeled 1 and 2, which opens to trade with the rest of the world, labeled 0. KE contains only one sector, which exhibits increasing returns to scale, and it comprises only mobile workers. Paluzie, as in the standard model of Krugman (1991), assumes a model with two sectors and two production factors: geographically mobile manufacturing workers, which produce a differentiated good under monopolistic competition and increasing returns to scale, and immobile agricultural workers, which produce an homogeneous good under perfect competition and constant returns to scale. There are transport costs both between the internal regions, labeled τ , and between the latter and the rest of the world, labeled η , being the transport cost equal from any of the regions to 0 ($\eta_{1,0} = \eta_{2,0}$). Transport costs are modeled with the iceberg approach, which assumes that the cost of transporting a good uses up only some fraction of the good itself, rather than using any other resources. They include not only physical transport costs, related to infrastructures, transport means and distance, but also barriers to trade.

The centripetal forces are represented in both models by backward and forward linkages, which express the fact that firms and consumers are interested in locating in the same region. Trade liberalization decreases these agglomeration forces as progressively more inputs are sourced from abroad and more output is sold in the exterior market, thus lowering the incentive for domestic firms to locate near other firms and domestic consumers.

The main difference between the two models lies in the repellent forces. In KE they are created by diseconomies associated to agglomerations such as congestion and high land costs and rents. As trading costs decrease significantly and the centripetal forces are diluted, firms tend to move away from the more congested region (where the centrifugal force is stronger) to the other region, in order to benefit from lower wages and rents. Through numerical simulations, KE observe 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, a concentration in one of the regions. However, when η is low enough, the only stable equilibrium is the symmetric distribution. The opening of trade may therefore lead to a dispersal of manufacturing industry across the country. We designate this hypothesis as [H1].

Yet, Paluzie, by assuming the immobility of agricultural inputs in opposition to those of manufacturing, replaces the centrifugal force of large commuting costs and land rents by the pull of the potential market of a dispersed agricultural population, as in Krugman (1991). When the country opens to trade, manufacturing firms are no longer constrained by the limited demand of domestic rural markets as they can service foreign demand and make use of cheaper foreign inputs. In this case, there is an incentive for manufacturing firms to locate where the centripetal forces are stronger, leading to more agglomeration.⁷ In sum, in contrast with KE, increased openness to foreign demand and supply decreases not only the centripetal forces but also the centrifugal ones.

With numerical simulations, Paluzie shows that the impact is stronger on the dispersion forces: while, for a high value for η , the symmetric distribution between the two domestic regions prevails, the consideration of a low value for η leads to a

core-periphery pattern, with all manufacturing industry concentrated in just one region. Paluzie's predicted outcome is, therefore, opposite to that obtained by KE: a reduction of international trading costs is more likely to lead the manufacturing sector to be spatially concentrated. We designate this hypothesis as [H1'].

Other extensions of the Krugman's (1991) model – thus also assuming a partially immobile population – to more refined settings also come out to Paluzie's conclusion. For instance, Monfort and Nicolini (2000) and Monfort and van Ypersele (2003) interact η with τ in a two internal regions and two countries' framework and conclude that openness to trade exacerbates the agglomeration forces at work inside the trading countries. In addition, Monfort and van Ypersele (2003) identify spatial correlation in the sense that countries' internal structures influence each other mutually and that both international integration and agglomeration in one country reduces the likelihood to observe agglomeration in the partner country. Crozet and Soubeyran (2004) model the possibility that the two domestic regions are not equidistant from foreign market ($\eta_{1,0} \neq \eta_{2,0}$) and show that trade openness will in general favor agglomeration of manufacturing activity in the region that has an advantage in terms of its access to international markets, unless competition pressure from foreign firms is too high.

Note, however, that Paluzie's result may also be obtained with KE centrifugal forces. Alonso-Villar (2001) shows that if a country is less developed (i.e. it produces few manufactured goods), since its firms are more dependent on the domestic market, even with congestion costs the result may be agglomeration and not dispersion, due to the competition effect: any deviating firm would not only lose a significant part of its national market but also would have to compete with the large foreign markets with many firms. Similarly, Mansori (2003) argues that, in the presence of congestion costs, trade liberalization may cause concentration of the economic activity if

increasing returns to scale in a country's transportation infrastructure exist, i.e. by introducing an additional agglomerative factor in assuming that the average cost of transporting goods may decline as the volume of trade grows.

Also relevant is the fact that the outcome is not clear-cut even with Krugman's (1991) assumption of a local immobile market. Behrens (2003) and Behrens et al. (2003), by using a quadratic utility function as opposed to the Dixit-Stiglitz's framework used in other studies, have shown that the final equilibrium depends on the relative values of international to interregional trading costs. The way international transport costs are modeled also seems crucial: decreases in *ad valorem* tariffs (associated to the commonly used iceberg costs of transportation) favor the agglomeration of economic activities, while decreases in transport costs and non-tariff barriers (modeled with linear costs of transportation) favor dispersion.

Summing up, whether international trade liberalization leads to regional concentration or to dispersion of the economic activity inside the country that progressively opens to trade appears to depend not only on the dispersion forces but also on several other parameters and no general consensus can be reached. On the present state of the theoretical research, only the empirical evidence will ultimately allow some light on this issue.

The literature above focuses on the impact of the reduction of international trading costs on the location of manufacturing industry at the aggregate level (i.e. including all sectors). However, the changing pattern of industrial location may not be uniform across sectors. Fujita et al. (1999, chapter 18) show that trade liberalization may bring a reduction of the spatial concentration of manufacturing activity and spatial clustering of particular sectors, i.e. regional specialization. This outcome is shown through numerical simulations in a model with centripetal forces given by

backward and forward linkages and centrifugal forces modeled with congestion costs. Starting with two regions, with an unequal distribution of population, the larger region producing two goods and the smaller region producing only one good, the reduction of trading costs leads to two effects. First, the larger region loses population to the smaller one. The reason is that the openness to international trade weakens both centripetal and centrifugal forces, as domestic firms are led to use a higher proportion of imported intermediate inputs and to sell a higher proportion of their own production in the foreign market and, considering the reduction in the cost of delivering goods, more citizens will prefer the region where congestion costs are lower. Second, the larger region becomes more specialized, losing production of the good initially produced in both regions to the other (smaller) location. The explanation is that external trade is somehow balancing supply and demand for each sector's product in each location, thus stimulating industrial specialization driven by intra-industry linkages. Further reductions of trading costs will lead the economy to the point where the two regions have equal populations and are both fully specialized in one of the sectors. External trade liberalization therefore generates dispersion of population but regional concentration of particular sectors. We designate this hypothesis as [H2].

3. Previous empirical evidence

With regard to the scant empirical research into the impact of the reduction of international trading costs on the economic geography of a country, the most comprehensive study in terms of the 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 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 as “arguably it is the country that undergone the deepest process of economic liberalization and regional integration in the world since the mid-1980s” (Rodríguez-Pose and Sánchez-Reaza, 2002, p. 4). Results suggest that the removal of trade barriers initiated in the mid-1980s as a consequence of the adhesion of Mexico to NAFTA, have contributed to the decentralization of Mexican industry away from Mexico City, as shown, for instance, by Krugman and Hanson (1993), Hanson (1998), Rodríguez-Pose and Sánchez-Reaza (2002) and Arias (2003).

De Robertis (2001) has analyzed the Italian case. With employment data in the period 1971-91 for 20 regions, the author confirms [H1]. Using the data of De Robertis (2001), 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 spatial concentration.

Some analysis on [H2] has also been conducted for several countries, but in general it has not been possible to draw up a clear conclusion. In a pioneering study on this topic, Hanson (1998) shows mixed evidence for the Mexican case. De

Robertis (2001) obtains contradictory results for Italy, depending on the industry analyzed, with the sharpest increase in spatial concentration occurring in the textile and clothing industries, while the transport sector shows the most significant opposite tendency.

Paluzie et al. (2001) present some evidence for Spain between 1979 and 1992 but the results do not provide a clear confirmation of [H2]. 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 display an increase in their level of spatial concentration. Moreover, these changes are, on average, very moderate.

4. Data and measurement of spatial concentration

To measure spatial concentration of manufacturing activity, we consider statistical information for Portugal in the period 1985-2000. We use employment data at 2 digit level of the *Classificação das Actividades Económicas* (CAE), revision 2, for manufacturing industry (sectors 15 to 37).⁸ This nomenclature is described in the Annex. The data is from *Quadros de Pessoal* – Ministry of Employment. In spatial terms, Portugal (excluding *Madeira* and *Açores*) consists of 5 NUTS II, 28 NUTS III and 275 *concelhos*.⁹ We opt for the two highest levels of disaggregation, thus allowing to test the robustness of the conclusions.

The starting point of the analysis is the consideration of a matrix X for each year, containing the volume of employment of each region, at a sectoral level. Matrix X has a generic element x_{ji} representing the employment in sector j ($j = 1, 2, \dots, J$) in region i ($i = 1, 2, \dots, I$), with $J = 22$ and $I = 28$ (in the case of the evaluation based on NUTS III) or 275 (in the case of the analysis based on *concelhos*). Manufacturing activity including all sectors will be designated by q .

As an intermediate step to obtain spatial concentration indices, we calculate a new matrix – matrix S –, with generic element $s_{ji} = x_{ji}/x_j$ where x_j is the total employment in sector j . Thus, the element s_{ji} represents the share of region i in the spatial distribution of sector j .

To get a vision as comprehensive as possible of the process of industrial relocation in the period analyzed, we use four alternative concentration concepts: absolute, relative, topographic and geographical. The absolute and the relative concentration concepts are the most used, specially the absolute one. Nevertheless, adding the topographic and the geographical concepts allow a more complete picture on this topic. Subsequently, we will present the indices related to these four concepts, which will be used in section 5.

(i) Absolute concentration

The concept of absolute spatial concentration only takes into consideration the distribution of sector j by the different regions. Spatial concentration of sector j will reach the maximum value when this sector is totally concentrated in only one region and the minimum value when it is equally distributed by all regions.

In order to capture this concept of concentration, we apply 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 ($h = 1, 2, \dots, I$) indicating the order; (ii) to obtain the partial accumulated values $d_{j(h)}$ such that $d_{j(1)} = a_{j(1)}$, $d_{j(2)} = d_{j(1)} + a_{j(2)}$, ..., $d_{j(I)} = d_{j(I-1)} + a_{j(I)}$; (iii) to define $c_{j(h)} = (h/I)$. The absolute Gini index for sector j is then given by:

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

The index $G_j^{(A)}$ will be equal to 1 when sector j is located in only one region. When sector j is distributed equally across all regions, $G_j^{(A)}$ will be 0.

(ii) Relative concentration

The relative indices compare the spatial distribution of sector j with the distribution of a sector taken as reference. As usually done, we use as reference “sector” the manufacturing industry as a whole and a consequence of this choice is that the relative index used in this study is appropriate only to analyze the spatial concentration of individual industries.

A commonly used measure of relative concentration is the so-called Krugman index (E_j), which can be expressed as:

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

We consider $\beta = 1/2$ as, in that case, E_j ranges between 0 and 1. If $E_j = 0$, the spatial distribution of sector j is identical to that of the manufacturing industry as a whole (q). E_j increases with the degree of dissimilarity between the two distributions considered.¹⁰

(iii) Topographic concentration

The two concentration concepts analyzed above correspond, as already emphasized, to the most commonly adopted in the empirical analysis. In the evaluation of absolute concentration all regions are considered as equal whereas the analysis of relative concentration assumes that the dimension of the regions has an economic character given by the importance of the economic activity as a whole located in the different regions. A complementary approach consists in considering the spatial dimension of the regions, evaluated by their area, and it characterizes the topographic concentration concept.¹¹

To evaluate the level of topographic concentration, we propose an approach based on the adaptation of the relative indices.¹² Let us define the area of region i as ψ_i . We can then calculate the share of the area of i in the total area of the country:

$$\varphi_i = \psi_i / \left(\sum_{i=1}^I \psi_i \right) \quad [3]$$

Using the Krugman index as reference (once again with $\beta = 1/2$), the degree of topographic concentration of sector j (TOP_j) can be measured as follows:

$$TOP_j = \frac{1}{2} \sum_{i=1}^I |s_{ji} - \varphi_i| ; TOP_j \in [0 ; 1[\quad [4]$$

The topographic index requires, for each region i , the comparison of the share of sector j located in region i (s_{ji}) with the share of region i in total area (φ_i). 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.¹³ Any other case leads to an increase of topographic concentration. Top_j assumes its maximum

value, converging to 1, when all the activity of sector j is located in the smallest region.¹⁴

(iv) Geographical concentration

The absolute, relative and topographic indices ignore the geographical position of the regions, i.e. they do not consider inter-regional distances. Nevertheless, it is also important to investigate if concentration occurs in close 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 sector 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. For each sector j , it is expressed as follows:

$$GL_j = \gamma \sum_{i=1}^I \sum_{k=1}^I (s_{ji} s_{jk} \delta_{ik}) ; GL_j \in]0 ; +\infty[\quad [5]$$

where γ is a constant (assumed to be equal to 1) and δ_{ik} represents the distance between regions i and k . GL_j is a weighted average of the bilateral distances between all the regions, taking as weight the share of each sector located in regions i and k .

A rigorous use of this last index requires data rather disaggregated at the geographical level, which led us to use it only in the case of the spatial disaggregation by *concelhos*. The calculation of GL_j considers 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 one which estimates the time (in minutes) needed to run, by car, that distance by taking into consideration the characteristics of the different roads (based on speeds pre-defined by the program) – GL(min). 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 where δ_{ii} is a measure of internal distance and ψ_i is the area of region i.

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

[Insert Figure 1 here]

5. Spatial adjustments of manufacturing industry in the Portuguese case

Next we analyze the spatial relocation of Portuguese manufacturing activity. We will start by showing evidence on the manufacturing industry at the aggregate level and afterwards we will consider the case of each individual sector.

5.1. Evidence on manufacturing industry at the aggregate level

A simple way to know whether the spatial structure of the manufacturing industry has changed significantly, during the period analyzed, consists on using the Lawrence index (T).¹⁵ For a given sector j, T_j allows to compare its spatial structure in two different years (in this case, 1985 and 2000). T_j is expressed as follows:

$$T_j = \frac{1}{2} \sum_{i=1}^I |S_{ji2000} - S_{ji1985}| ; T_j \in [0 ; 1] \quad [6]$$

T_j ranges between 0 and 1, increasing with the transformation level of the spatial distribution of sector j .

Figure 2 presents the results concerning manufacturing industry as a whole (T_q), between 1985 and 2000.

[Insert Figure 2 here]

The evidence presented in Figure 2 suggests a significant transformation in the spatial distribution of manufacturing industry by the Portuguese NUTS III ($T_q = 0.178$), more remarkable in the sub-period 1990-1995. Calculating the annual variations in the whole period analyzed, we observe that the spatial transformation is more evident in the post-Single Market period, namely, by decreasing order, between 1995-1996, 1996-1997 and 1993-1994. These results are strongly corroborated by the analysis performed at the *concelhos* level.

Further evidence on the evolution of spatial concentration of manufacturing industry is obtained with the indices presented in section 4. Figure 3 shows the results. Note that in the case of the evaluation by NUTS III, we only use the absolute and the topographic indices as the geographical index requires information at the *concelhos* level and the relative index is adequate only for individual sectors.

[Insert Figure 3 here]

The analysis by NUTS III shows an evident decrease of the absolute and topographic concentration between 1985 and 2000, as respectively shown by $G_q^{(A)}$

and TOP_q . In fact, according to the two indices considered, the maximum value is registered in 1985 and the minimum in 2000.

Figures 4 and 5 present a picture of the regional distribution of manufacturing industry at the NUTS III level in 1985 and 2000, respectively. We have considered four ranges for the share of manufacturing industry located in each region (s_{qi}). During the period analyzed, it is possible to observe that manufacturing industry is mainly concentrated in two major industrial regions: *Grande Lisboa* in the south (which includes the political centre of the country and is among the major financial and economic centres of the Iberian Peninsula) and another one in the north, consisting on *Grande Porto* in 1985 and *Grande Porto, Ave, Tâmega* and *Entre Douro e Vouga* in 2000.

[Insert Figures 4 and 5 here]

It is noteworthy that the two regions with the highest share of 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 highest reduction among all regions considered. *Serra da Estrela*, *Península de Setúbal*, *Algarve* and *Cova da Beira* also have a reduction in the share of manufacturing industry located in those regions. Besides, *Tâmega*, *Baixo Vouga* and *Cávado*, all of them with a low share of manufacturing industry in the beginning of the period, display the most relevant increases of their shares. This general tendency is confirmed by the correlation coefficient between s_{qi1985} and $(s_{qi2000} - s_{qi1985})$, as the value obtained (- 0.752) reflects the reduction of the concentration in the initially more congested regions.

Turning now our attention to the spatial disaggregation by *concelhos*, the results (presented in Figure 3) are concordant with the results for the NUTS III level. In fact, there is a significant reduction of the degree of absolute and topographic concentration of manufacturing industry.

In its turn, the geographical concentration index reveals a decrease of the geographical separation between the regions where manufacturing activity is located (for instance, GL (min) decreases from 125.26 in 1985 to 123.75 in 2000). Note however that a decreasing tendency is compatible with a more uniform distribution of manufacturing industry in the national territory – in line with the picture given by the remaining indices –, but it can also express a stronger concentration in close regions.

The share of each region in the spatial distribution of manufacturing industry at the *concelhos* level 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 strong reduction of the relative weight of *Lisboa* – which had only 3.9% of manufacturing industry in 2000 – and of *Porto* – with a share of 2.3% in 2000. The correlation coefficient between S_{qi1985} and $(S_{qi2000} - S_{qi1985})$ at this spatial disaggregation level (- 0.814) confirms the result previously presented.

The global conclusion which emerges from the evidence above is that during the trade liberalization process that followed adhesion to the EU, there was a clear dispersion of manufacturing industry in the internal Portuguese space. Besides, the initially more congested areas lost a significant share of manufacturing industry.¹⁶

5.2. Evidence on individual sectors

After Portuguese accession to the EU, the specialization pattern of the Portuguese economy underwent major changes. In parallel with a reduction in the share of the manufacturing industry, the relative importance of its sub-sectors also changed. The share of the so-called traditional sectors (wood, cork, paper, skins, leather, textiles, clothing, footwear) – i.e. those more labor intensive and related to the exploitation of natural resources – decreased¹⁷, while the share of machinery, vehicles and other transport equipment – the sectors with the highest FDI inflows in terms of foreign equity in Portuguese manufacturing – increased. In the period 2000-2003, the share of this last group overcame the traditional one, a notable feature considering the predominance of the traditional sectors in the past. Despite these changes, in the 2000-2003 period the share of the traditional sectors in total exports was still much higher for Portugal than was the case for the EU15 average (respectively 33.3% and 8.7%), or even in countries like Spain or Greece.

A global view of the location of individual sectors in the Portuguese case shows that, in general, traditional sectors that are more intensive in low-skilled labor predominate in the North (*Grande Porto* and neighboring regions), while the more modern sectors (chemicals, metallurgy, machinery and transport) are mainly concentrated in the *Grande Lisboa* with a secondary focus in the North (Flôres et al. 2007).

Focusing now our attention on the evolution of the location of each individual sector at both levels of disaggregation considered in this study, we start, once more, by evaluating the transformation of the spatial distribution with the Lawrence index (T_j). Figure 6 presents the results.

[Insert Figure 6 here]

Figure 6 shows a significant transformation of the pattern of sectoral location 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 spatial transformation, showing, respectively, the 6th and 12th position in terms of spatial stability. In an evaluation by sub-periods, 14 sectors have their highest spatial transformation between 1990 and 1995.

Results at the *concelhos* level are similar to those for the NUTS III with regard to the sectors with the sharpest spatial transformation during the period studied. However, in this case, it is also important to mention sector 34 (motor vehicles), besides two sectors (16 – tobacco – and 37 – recycling) that are not relevant in the Portuguese case.

A relevant observation emerging from the results for the Lawrence index in annual terms, at both levels of disaggregation, is that, confirming the results at the aggregate level, spatial transformation is more accentuated in the post-Single Market, suggesting that the above-mentioned studies for the EU space that do not include this period may have underestimated the real impact of trade openness.

In relation to the evolution of the spatial concentration level of each sector, we apply the four concepts of concentration considered in section 4. In order to reduce the vast volume of information that is obtained with calculations at the sectoral level, Figure 7 indicates whether the sector registers a concentration increase (+) or a concentration decrease (-) in the period analyzed.

[Insert Figure 7 here]

In what concerns the geographical concentration index, the time evolution of this index cannot be unequivocally compared with the time evolution of the remaining concentration indices. For instance, a decrease of this index (which occurs in nine sectors) shows a reduction of the average distance between the regions where the sector is located, but this evolution can occur both with a more uniform spatial distribution of that sector or with a stronger concentration in close regions. Interestingly enough, a comparison of the time evolution of the three other concentration indices shows 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.

Let us observe that in the analysis by NUTS III, 13 sectors reveal an increase of relative concentration while only 10 sectors show an opposite tendency. In turn, the analysis based on the absolute index tells us that only sector 19 (leather products and footwear) registered an increase of concentration during the period studied. The topographic concentration index corroborates this latter tendency as, according to this index, only sectors 29 (machinery and equipment n.e.c.) and 30 (office machinery and computers) 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 the relative index signals an increasing tendency in 17 cases.¹⁸

How do we explain the distinct message given by the different indices? The main explanation appears to be related to the fact that the use of relative indices

presupposes the stability of the manufacturing industry at the aggregate level (when this is the sector taken as reference, as it is usually the case). Nevertheless, in the present study, we have shown evidence of a strong transformation of the spatial distribution of the manufacturing industry. This fact causes an increase of the value of the relative index for each individual sector which is not related to a spatial transformation of that sector. Therefore, when this is the case, it seems more appropriate to base the analysis for individual sectors on the absolute and topographic indices. Our results put a grain of doubt on previous studies that used relative indices whenever the spatial distribution of manufacturing industry as a whole is not stable in the period analyzed.

Finally, we evaluate the evolution of the similarity degree of the sectoral structures of the different regions. An increase of regional specialization will be expressed in a growing divergence between their sectoral structures. For this purpose, we calculate the Krugman index in bilateral terms between all the pairs of regions for each year. With the matrices containing this information, it is possible to obtain, for each level of disaggregation and for each region, the simple averages in each year, which give us an indication of the degree of similarity between the sectoral structure of each region vis-à-vis all the others.

Figure 8 shows, at the NUTS III level, the evolution between 1985 and 2000 of the degree of similarity between each region and the remaining ones, calculated as explained above.

[Insert Figure 8 here]

Noting that a negative variation signals a convergence of the sectoral structure of that region with the others while a positive variation means a movement of structural divergence, Figure 8 clearly suggests that, in the period analyzed, sectoral structures of the different regions became more similar. In fact, only two NUTS III (*Cávado* and *Beira Interior Sul*) display structural divergence between 1985 and 2000, evaluated in average bilateral terms. This conclusion is also valid at the *concelhos* level, as only 66 of them diverged, in average terms, from the others. These results are in line with the conclusion that emerges from the indices of absolute and topographic concentration presented above.

6. A relationship between trade and the relocation of manufacturing industry in Portugal?

The empirical evaluation conducted in the previous section permitted us to conclude that the period immediately following Portugal's entry into the EU was characterized, both at the manufacturing industry level in aggregated terms and in the majority of sectors considered individually, by a trend to spatial dispersion.

The reduction of the international trading costs is a possible explanation for the revealed trend. As expressed in the Introduction, entry into the EU brought a substantial opening up of trade to Portugal. As a result of this opening up to the exterior, not only the weight of exports in the GDP increased strongly in the period immediately after EU entry, but Portuguese foreign trade registered an important and significant change in its geographical direction, in favor of the EU partner countries (with 80.3% of total exports and 75.1% of total imports taking place with the EU in

2000). However, other factors may also have impacted on the spatial adjustments observed.

Ideally, the effect of trade openness on the regional disparities should be evaluated with a formal model. Data constraints related to the number of observations (16 years) and to the building of some of the explanatory variables hinder such an attempt.¹⁹ However, a discussion of the possible explanatory factors of the spatial relocation of manufacturing industry in the Portuguese case allows to draw relevant insights on this topic.

In addition to cross-border trade liberalization, the influence of at least four other determinants of the relocation of manufacturing industry are worthy of consideration in the Portuguese case: (i) a structural transformation, with the substitution, in the most developed and initially most congested regions, of industrial sectors by services sectors; (ii) the entry of FDI; (iii) the reduction of internal trading costs; and (iv) the existence of regional policies that favor locations in less congested and less developed areas, aiming for greater internal cohesion. We continue next with an analysis of the relevance of each of these four factors during the period under consideration in the present study.

With regard to structural transformation, identified by Kuznets as one of the main characteristics of the development process, it is well known that as the regions develop, they substitute agricultural activities by industrial activities and, at a more advanced stage, by services.

In Portugal's case, we can observe that the regions that displayed the highest levels of concentration in terms of industrial activity in the first year analyzed were those that registered a greater degree of development. They are situated along the Portuguese coastal strip, in which the *Grande Lisboa* and *Grande Porto* regions

predominate. Thus, it is possible to believe that between 1985 and 2000, these regions experienced a substitution of industrial sectors by services, while the regions that were initially less developed registered a transformation from agricultural to industrial sectors.

A way to evaluate the validity of this hypothesis consists of complementing the analysis of the industrial sectors conducted in the preceding sections with a similar procedure with regard to services.²⁰ Carrying out this analysis enables us to identify that the dispersion trend found in the industrial sectors is replicated in the service sectors, as illustrated by three facts. First, the Herfindahl spatial concentration index was higher for services than for manufacturing industry, but decreasing in both cases.²¹ Second, the correlation coefficient between the variation of the share of manufacturing industry located in each region and the analogous variation for the service sector in the period analyzed was positive (0.67), pointing to a similar spatial location trend in both cases. Third, it is of interest to note that the most congested regions at the beginning of the period (*Lisboa* and *Porto*) lost not only manufacturing, but also services to other regions. Thus, the evidence in relation to the service sectors does not seem overall to lend support to the hypothesis of structural transformation as a relevant explanation for the movement observed at the industrial level.

A second explanation for the evidence obtained in the preceding section might be found in the inward FDI. The flows of FDI into Portugal have been an important factor in the national economy since joining the EU, with two periods of particularly strong growth registered during the post-1986 years. The first occurred immediately after entry, while the second period, which was stronger, took place in the second half of the 1990s, the effects of which were felt in years later than those analyzed in the present paper. Nevertheless, we cannot dismiss the possibility that the first wave of

inward FDI contributed to a change in the location profile of manufacturing industry in Portugal. Indeed, if the multinational companies displayed evidence of a spatially more dispersed pattern of location, this would help to explain the evidence found.

However, observation of the spatial distribution of the FDI does not corroborate this hypothesis. Effectively, a highly significant proportion of the FDI flowing into Portugal in the manufacturing sector is located in the regions that were identified as having the highest proportion of economic activity.

To illustrate this fact, we turn once again to the information available in the Ministry of Employment's *Quadros de Pessoal*, but this time in relation to multinational companies. From this information, we verify a high correlation (approximately 0.70) between the locational distribution (by *concelhos*) of the total economic activity and that proportion that refers only to multinational companies operating in Portugal. Furthermore, and using data for the last year of the period under analysis, it is possible to verify that the 15 *concelhos* with the largest volume of employment in multinational enterprises are all situated in the above-mentioned coastal strip, in which the greatest proportion of economic activity in global terms is also concentrated.

A third reason that could be put forward to explain the trend towards industrial dispersion resides in the reduction of internal trading costs, even if the relation between reduced transportation costs and the location of economic activity is complex and non-linear (Krugman, 1991), precluding a clear forecast of the impact of such a reduction on the location of economic activity.

In fact, from the start of Portugal's EU membership to the present day, there is clear evidence of a significant reduction of transportation times and, consequently, of internal transport costs. However, the construction of transport infrastructures and the

consequent reductions in journey times and transport costs apparently cannot be put forward as principal explanations for the trend revealed since, on one hand, the completion of these projects largely took place after the phase of major structural transformation of the location profile of Portuguese industry, i.e., the first half of the 1990s (see Table 2), and, on the other hand, the road network built in the first half of the 1990s, particularly the highways, are strongly concentrated in the regions with the most significant proportion of the country's industrial activity.²² This last point is reinforced if we consider the railway network, which is also concentrated in the economically most congested areas and where the highest speeds and by far the greatest volumes of traffic are attained.

Another important reason that could justify the movement from the more central regions towards the less developed regions may be the existence of regional policies, conceived at local or national level and designed to attract economic activity to the less developed regions in order to promote their economic development.

As emphasized by Syrett (1995) and Freitas et al. (2005), in Portugal, the regional authorities' policy discretion is very limited. However, some national public expenditures are closely tied to EU Structural Funds, including the European Regional Development Fund to reduce regional imbalances, which amounted to roughly 3% of GDP per year. Portugal also benefited from the Community's Cohesion Funds that were introduced in the early 1990s. Together, these funds aimed to promote basic infrastructures in transport, communication, social infrastructures, incentives to the business sector and to cross-border cooperation, among other factors that may have facilitated the spreading out of the firms.

Despite the quantitative importance of these national forms of support, they were not sufficient to avoid real divergence among the regions of Portugal. In fact,

Freitas et al. (2005) have shown, for the period 1995-2000, a divergence between the Portuguese regions both in per-capita and gross value added per-worker terms. One of the factors contributing to this divergence could have been the fact that in certain periods, in particular during the time that the Second Community Support Framework was in force, the funding per capita for the poorest regions was substantially lower than that for the richest regions (Freitas et al., 2005).

In conclusion, all of these potentially explanatory factors do not seem to explain sufficiently the evidence presented in the preceding section, leaving the reduction of international trading costs as a reasonable explanation for the trend observed.

A simple way of evaluating the relation between trade liberalization and the industrial dispersion trend revealed in Portugal is to calculate the correlation coefficient between the measurements of spatial concentration used in the preceding section and a measurement of trade intensity.²³ The results of this calculation are presented below in Figure 9, which considers this relation for the world, the EU space and the case of Spain.

Among EU partners, the importance of Spain must indeed be stressed. In spite of being the only country with which Portugal shares a common frontier, trade between both countries remained at low levels before 1986. In part the reason is related to the fact that, in spite of a resurgence of import substitution during the latter-1970s and early 1980s, basically made up of non-tariff barriers (Fontoura and Valério, 1994), Portuguese trade on industrial goods became progressively free of tariffs since the beginning of the 1970s with EU members. In contrast, high levels of commercial protectionism were maintained with Spain until both countries joined the EU. As customs duties with Spain were abolished after 1986 (until 1992, in what regards

industrial goods), the weight of this country in Portugal's trade increased substantially (Portuguese exports to this country increased from 4.1% to 19.3% between 1985 and 2000, while imports from Spain into Portugal rose from 7.4% to 25.9% in the same period). In the end of the period analyzed, Spain was already the principal trading partner of Portugal.

[Insert Figure 9 here]

The results presented in Figure 9 suggest that the increased importance of trade in the Portuguese case is clearly (and negatively) associated with the level of spatial concentration of industry in the Portuguese internal space, both when the evaluation is based on a spatial disaggregation by NUTS III and by *concelhos*. This assertion is particularly relevant to the EU case, but even more so in relation to Spain. In both cases, trade liberalization and the subsequent reduced costs of international trade have more significance in the post-EU entry phase.

Interestingly enough is the fact that the calculations made in Section 5, above all at the level of *concelhos*, show that the regions with the highest proportion of manufacturing industry and in which the most significant reduction of industrial presence took place are those which are most distant from the Spanish frontier. Therefore, the reduction of international trading costs appears to have led, taking into account the importance of the trading relations with Spain, to industrial dispersion to regions that are less congested and nearer to the frontier with Spain.

To sum up, the evidence presented in this section seems to indicate that the reduction of international trading costs has contributed significantly to explaining the observed intra-national location dynamics of manufacturing activity.

7. Final remarks

The empirical analysis for Portugal between 1985 and 2000 concerning manufacturing industry shows a dispersion of this economic activity, both at the aggregate level and for individual sectors.

The evidence for the aggregated manufacturing industry is in line with the hypothesis established by KE. In fact, it is our contention that while several factors may have contributed to determine the industrial spatial adjustments observed in this study, trade openness was relevant and, apparently, the most important.

At first glance the dispersion movement observed is contradictory to the fact that, in the Portuguese case, labor mobility is restricted, since there is a high level of job protection and high private costs to geographic mobility due to housing market restrictions. Apparently, congestion costs in the more concentrated regions were the prevalent centrifugal force that led to spatial decisions.

On the other hand, we conclude that individual sectors became more dispersed in the Portuguese territory in the period analyzed, leading to convergence between the different regions in terms of their sectoral structure. This result is in contrast to what has been predicted by Fujita et al. (1999), pointing to the need for future research on the spatial adjustments of individual sectors, both in theoretical and empirical terms. It is possible that the decisive determinants of within-sectors' locational decisions are related to sectoral characteristics, as shown for instance by Faber (2007) for the Mexican case.

Finally, as mentioned in the Introduction, it has been assumed that structural convergence should lead to real convergence. However, there is no evidence of real convergence at the regional level in the Portuguese case during the period analyzed.

Other factors may thus have explained the increased regional inequalities in the standards of living, counteracting the benefits of increased dispersion of manufacturing industry.

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Figure 1 - Concepts of spatial concentration

Concentration concept	Index	Question to evaluate	Maximum concentration	Minimum concentration
Absolute	$G_j^{(A)}$	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	E_j	How similar are the spatial distributions of sector j and of the total economic activity?	Maximum divergence between the distributions of sector j and that of the total economic activity (where sector j is located, there are no other sectors)	The distribution of sector j is identical to that of total economic activity
Topographic	TOP_j	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	GL_j	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.

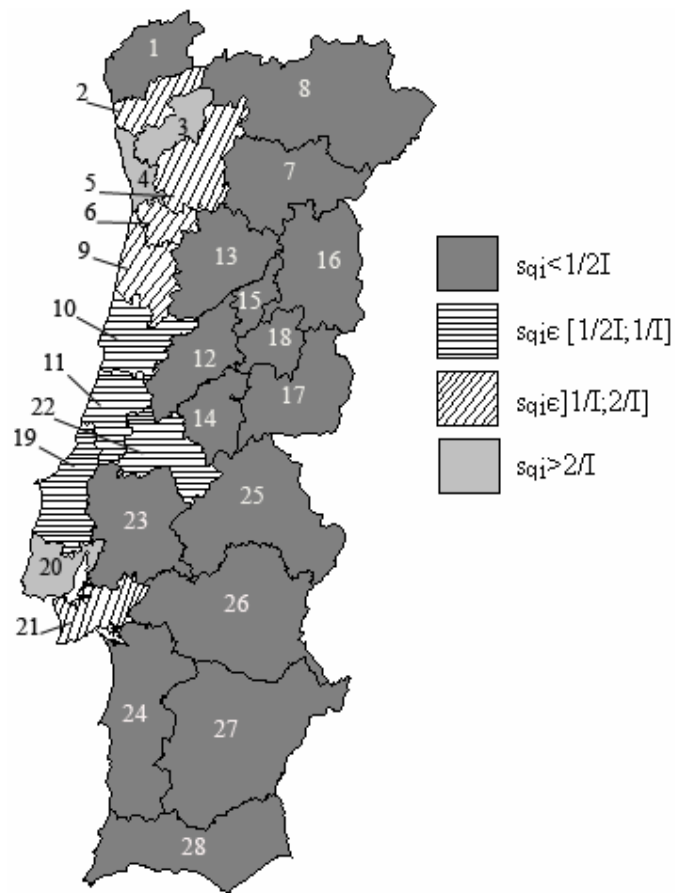
Figure 2 - Structural transformation of the spatial distribution of manufacturing industry, 1985-2000

Period	T_q (by NUTS III)	T_q (by <i>concelhos</i>)
1985/1990	0.065	0.095
1990/1995	0.084	0.112
1995/2000	0.047	0.081
1985/2000	0.178	0.241

Figure 3 - Level of spatial concentration of manufacturing industry by NUTS III and *concelhos*, 1985-2000

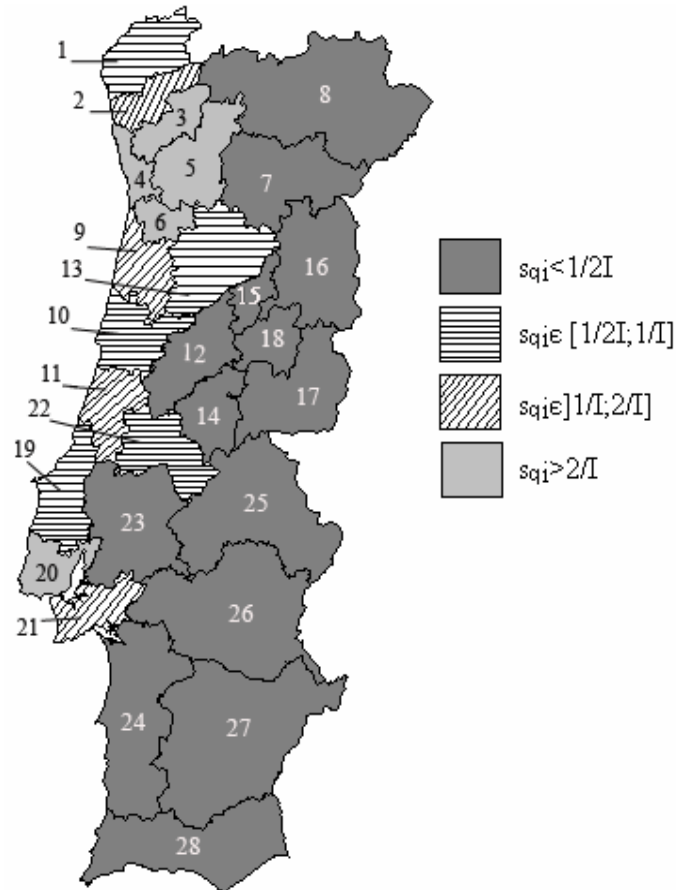
Year	By NUTS III		By <i>concelhos</i>			
	Absolute concentration ($G_q^{(A)}$)	Topographic concentration (Top_q)	Absolute concentration ($G_q^{(A)}$)	Topographic concentration (Top_q)	Geographical concentration ($GL_q(km)$)	Geographical concentration ($GL_q(min)$)
1985	0.693	0.683	0.829	0.752	188.34	125.26
1986	0.686	0.678	0.825	0.750	187.25	124.81
1987	0.682	0.680	0.824	0.750	186.19	124.29
1988	0.675	0.677	0.817	0.745	185.37	123.98
1989	0.676	0.680	0.817	0.747	184.01	123.19
1990	0.673	0.680	0.812	0.744	183.76	123.16
1991	0.659	0.671	0.803	0.736	184.41	123.87
1992	0.652	0.669	0.798	0.732	184.39	124.05
1993	0.643	0.662	0.791	0.726	184.44	124.27
1994	0.628	0.656	0.780	0.716	183.51	124.14
1995	0.623	0.654	0.777	0.714	184.17	124.59
1996	0.615	0.647	0.775	0.711	183.56	124.45
1997	0.611	0.648	0.765	0.702	181.92	123.67
1998	0.609	0.647	0.764	0.702	182.03	123.71
1999	0.608	0.647	0.761	0.703	183.21	124.33
2000	0.606	0.643	0.758	0.698	181.93	123.75

Figure 4 - Spatial distribution of manufacturing industry by NUTS III (1985)



1-Minho-Lima; 2-Cávado; 3-Ave; 4-Grande Porto; 5-Tâmega; 6-Entre Douro e Vouga; 7-Douro; 8-Alto Trás-os-Montes; 9-Baixo Vouga; 10-Baixo Mondego; 11-Pinhal Litoral; 12-Pinhal Interior Norte; 13-Pinhal Interior Sul; 14-Dão-Lafões; 15 - Serra da Estrela; 16-Beira Interior Norte; 17-Beira Interior Sul; 18-Cova da Beira; 19-Oeste; 20-Grande Lisboa; 21-Península de Setúbal; 22-Médio Tejo; 23-Lezíria do Tejo; 24-Alentejo Litoral; 25-Alto Alentejo; 26-Alentejo Central; 27-Baixo Alentejo; 28-Algarve.

Figure 5 - Spatial distribution of manufacturing industry by NUTS III (2000)



1-Minho-Lima; 2-Cávado; 3-Ave; 4-Grande Porto; 5-Tâmega; 6-Entre Douro e Vouga; 7-Douro; 8-Alto Trás-os-Montes; 9-Baixo Vouga; 10-Baixo Mondego; 11-Pinhal Litoral; 12-Pinhal Interior Norte; 13-Pinhal Interior Sul; 14-Dão-Lafões; 15 - Serra da Estrela; 16-Beira Interior Norte; 17-Beira Interior Sul; 18-Cova da Beira; 19-Oeste; 20-Grande Lisboa; 21-Península de Setúbal; 22-Médio Tejo; 23-Lezíria do Tejo; 24-Alentejo Litoral; 25-Alto Alentejo; 26-Alentejo Central; 27-Baixo Alentejo; 28-Algarve.

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

Sector	T _j (by NUTS III)				T _j (by <i>concelhos</i>)			
	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(a)	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(b)	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

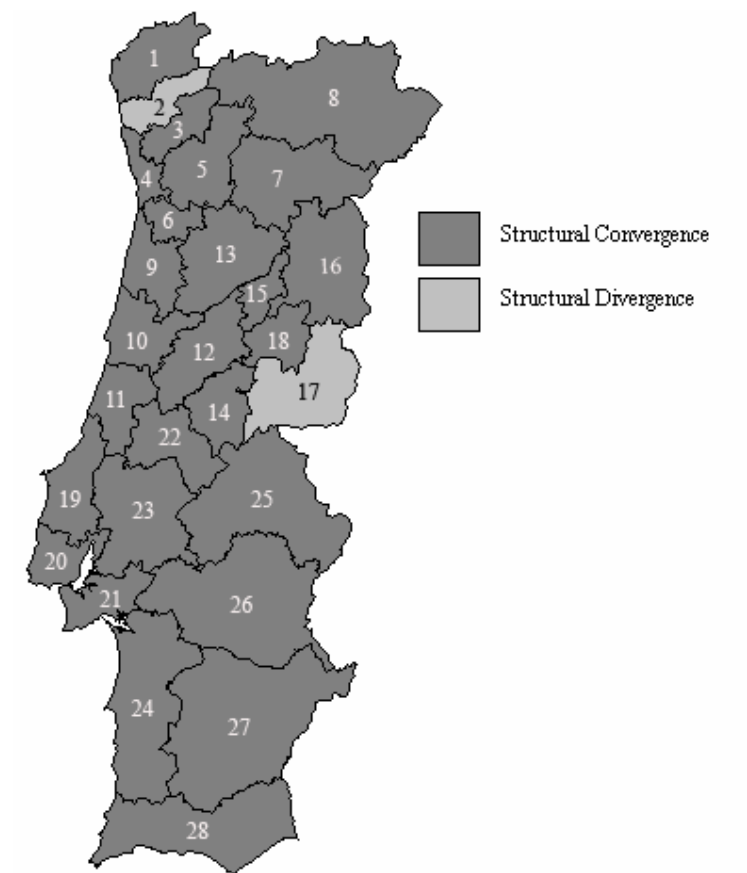
(a) last year:1999; (b) last year:1997

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

Sector	by NUTS III			by <i>concelhos</i>			
	Absolute concentration	Relative concentration	Topographic concentration	Absolute concentration	Relative concentration	Topographic concentration	Geographical concentration
	($G_j^{(A)}$)	(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

Figure 8 - Structural convergence at the regional level, 1985-2000



1-Minho-Lima; 2-Cávado; 3-Ave; 4-Grande Porto; 5-Tâmega; 6-Entre Douro e Vouga; 7-Douro; 8-Alto Trás-os-Montes; 9-Baixo Vouga; 10-Baixo Mondego; 11-Pinhal Litoral; 12-Pinhal Interior Norte; 13-Pinhal Interior Sul; 14-Dão-Lafões; 15 - Serra da Estrela; 16-Beira Interior Norte; 17-Beira Interior Sul; 18-Cova da Beira; 19-Oeste; 20-Grande Lisboa; 21-Península de Setúbal; 22-Médio Tejo; 23-Lezíria do Tejo; 24-Alentejo Litoral; 25-Alto Alentejo; 26-Alentejo Central; 27-Baixo Alentejo; 28-Algarve.

Figure 9: Correlation coefficient between trade intensity* and spatial concentration by NUTS III and *concelhos*, Portugal, 1985-2000

	World	EU	Spain
By NUTS III			
$G_q^{(A)}$	- 0.047	- 0.748	- 0.920
Top_i	- 0.022	- 0.690	- 0.887
By <i>concelhos</i>			
$G_q^{(A)}$	- 0.079	- 0.755	- 0.934
Top_i	- 0.081	- 0.728	- 0.915

*(exports+imports)/GDP

Annex

CAE rev. 2/ NACE nomenclature

- 15 – Manufacture of food products and beverages
- 16 – Manufacture of tobacco products
- 17 – Manufacture of textiles
- 18 – Manufacture of wearing apparel; dressing and dyeing of fur
- 19 – Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear
- 20 – Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
- 21 – Manufacture of pulp, paper and paper products
- 22 – Publishing, printing and reproduction of recorded media
- 23 – Manufacture of coke, refined petroleum and nuclear fuel
- 24 – Manufacture of chemicals and chemicals products
- 25 – Manufacture of rubber and plastic products
- 26 – Manufacture of other non- metallic mineral products
- 27 – Manufacture of basic metals
- 28 – Manufacture of fabricated metal products, except machinery and equipment
- 29 – Manufacture of machinery and equipment n.e.c.
- 30 – Manufacture of office machinery and computers
- 31 – Manufacture of electrical machinery and apparatus n.e.c.
- 32 – Manufacture of radio, television and communication equipment and apparatus
- 33 – Manufacture of medical, precision and optical instruments, watches and clocks
- 34 – Manufacture of motor vehicles, trailers and semi-trailers
- 35 – Manufacture of other transport equipment
- 36 – Manufacture of furniture; manufacturing n.e.c.
- 37 - Recycling

Endnotes

¹ The financial support provided by the Fundação para a Ciência e a Tecnologia under SFRH/BD/6412/2001 (supported by the European Social Fund) is gratefully acknowledged. The usual disclaimer applies.

² In fact, the NEG pioneering models borrowed and adapted ideas previously developed by regional economics (see, for instance, Myrdal, 1957; Hirschman, 1958; Pred, 1966; Dixon and Thirlwall, 1975). See also Martin and Sunley (1996) for a critical assessment of Krugman's NEG, namely its emphasis on pecuniary externalities, dealing only briefly with technological externalities, and the exclusion of noneconomic factors as they are not easily tractable in mathematical terms.

³ See, for instance, Brülhart and Traeger (2005).

⁴ Note that in the context of the endogenous-growth literature, there are theoretical grounds for believing that concentrating industry may be beneficial for real income growth in all regions (Baldwin and Forslid, 1999; Martin and Ottaviano, 1999). Indeed, centripetal forces in the NEG terminology, such as technological spillovers or production externalities, are growth-inducing and, in the long run, a presumption is that dynamic gains of agglomeration of economic activity help to offset the static income losses in regions that lose industry.

⁵ Similarly to previous studies, we do not consider the service sector. One reason is related to data limitations, as the sectoral nomenclature has changed significantly during the period analyzed, making impossible a reliable conversion. It is nonetheless worth mentioning that the theoretical approach was delineated for the manufacturing industry.

⁶ For a critical assessment of this model, see Henderson (1996) and Isserman (1996).

⁷ Besides, with trade liberalization, competition exerted by foreign firms may become large compared to the competition of other domestic firms, thus lowering the need for domestic firms to locate far from domestic competitors and constituting an additional element to weaken the dispersion of economic activity.

⁸ At this level of aggregation, this nomenclature is fully compatible with NACE-Eurostat. Until 1994, the information is presented according to CAE – revision 1. Therefore, this information was converted into revision 2 according 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 the revision 2. For this reason, it was not possible to work with higher sectoral disaggregation levels.

⁹ Since 1999, there are three new *concelhos*. In order to assure compatibility, we affect the values of x_{ji} of the 3 new *concelhos* to the ones they belonged before 1999, taking the area as weight. In only one case it is necessary to follow this procedure as in the two other cases each new *concelho* is originated entirely in only one *concelho*.

¹⁰ When the “sector” of reference is the manufacturing industry at the aggregate level, E_j never reaches 1.

¹¹ This concept is more relevant if the dissimilarity between the regions is significant in terms of their dimension, which is the case in the present analysis: the area of the Portuguese *concelhos* ranges between 7.97 Km² (São João da Madeira) and 1721.42 Km² (Odemira).

¹² For an alternative perspective, see Brülhart and Traeger (2005).

¹³ Obviously, it is assumed a uniform intra-regional distribution. Therefore, the real topographic concentration is sub-evaluated. A way of minimizing this problem is to

use a very disaggregated geographical information. The development of more sophisticated indices considering this type of information is an interesting research topic. On this matter, see Brülhart and Traeger (2005).

¹⁴ Top_j never reaches 1 since that would imply that all the activity of sector j is located in a region with area equal to zero.

¹⁵ See for instance Lawrence (1984).

¹⁶ As a test of robustness, we have calculated the absolute and the topographic indices without the two more congested regions (*Lisboa* and *Porto*) and the results show, as expected, a reduction of the concentration levels. However, the decreasing tendency observed when we include all regions remains valid.

¹⁷ With respect to clothing and footwear, the loss of importance was visible only after 1993, since its share even increased until this year.

¹⁸ As a test of robustness, we have calculated the traditional relative Gini index for the two spatial levels that have been used. The results show a high consistency with the evidence displayed by E_j .

¹⁹ For a modelling approach to regional disparities not in terms of the productive structure, as in the case of this paper, but in terms of earnings, see Leichenko and Silva (2004) and Silva and Leichenko (2004). Rodríguez-Pose and Gill (2006) build a simple model that seeks to examine the relationship between trade and regional income disparities across countries, thus increasing substantially the number of observations. For the analysis of a different question, namely the sectoral differences in the spatial adjustment to liberalization, see Faber (2007).

²⁰ The agricultural sector was excluded from the analysis, due to its low value.

²¹ In fact, the Herfindahl index in 1985 was 0.047 for manufacturing industry and 0.131 for the services, while in 2000 it was, respectively, 0.019 and 0.097.

²² The country's most important inter-city highway was completed in 1991. This is the A1, which connects the two principal cities of Portugal (*Lisboa* and *Porto*) and passes through the regions in which the greatest concentration of industrial activity was located during the period analyzed. In the same year, the A5 highway between *Lisboa* and *Cascais* was completed, serving several of the *concelhos* in which a high proportion of the industry in *Grande Lisboa* is concentrated. The expansion and improvement of the national road network to the furthest regions took place above all only at the end of the 1990s and the start of the present decade. Examples are the A3, from *Porto* to the northern frontier at *Valença*, which was opened in 1998; the A6, which runs east from *Lisboa* to the Spanish frontier, crossing the *Alentejo* region, completed in 1999; and the A2, which is the vital highway south from *Lisboa* to the *Algarve* coast, concluded in 2002.

²³ McCann (2005) has shown that models constructed using Krugman-iceberg transport costs can never lead to a direct measurement of transport costs, which helps to justify the use of indirect methods, as it is the case of this proxy.