The Effects of European Union Trade Liberalisation on the Spanish Regions

by

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Abstract

This paper examines the effects of EU trade liberalisation on changes in the structure and concentration of manufacturing industries in Spain. To achieve this objective, the analysis develops a simple three-region model to classify a country’s administrative regions into Core regions, Adjacent regions, and Periphery regions. The significance of this three-region CAP model is that it can be extended into a multi-regional CAP-model to provide a framework for analysing the forces of agglomeration and dispersion at the national regional levels where the shocks of economic integration are initially felt.

The model allows for the identification of CAP clusters within a country thereby revealing multi-agglomerate production structures and changes in their composition due to the endogenous forces of trade liberalisation. Since the CAP model is a national regional model, in contrast to a national geographic model as found in the empirical literature, it has necessitated the development of a new regional industry concentration measurement. The measurement is called the ‘manufacturing labour-land concentration ratio’, which simultaneously reveals relative and absolute regional industry concentration.

This ratio facilitates the analysis and comparison of regional manufacturing concentration per CAP cluster, the characteristics of industries locating in each region type, and the characteristics of the CAP regions that attract specific industries. Finally, this paper addresses the empirical findings of Midelfart et al., (2000), that ‘the spatial distribution of European manufacturing appears to be driven by developments in Southern Europe.’ Their outcomes suggest a strong geographic competition effect in Spain that outweighs the agglomeration effect of the geographic core. The empirical analysis of this study appears to support the self-sufficiency theory of Venables and Limao (2002) based on a country’s location, endowment of primary factors of production, commodity characteristics of transportation intensity, and factor endowments.

Keywords: economic geography, regional nomenclature, CAP model, concentric circle theory, agglomerate, multi-agglomerate geography model

JEL Classification: F12, F15, J21, R11, R12, R23

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1. Introduction

This paper examines the effects of EU trade liberalisation on changes in the structure and concentration of manufacturing industries in Spain. To achieve this objective, the analysis develops a new simple national three-region geography model to classify a country’s administrative regions into Core, Adjacent, and Periphery – (CAP) regions. The significance of this three-region CAP model is that it can be extended into a multi-regional CAP-model to provide a framework for analysing the forces of agglomeration and dispersion on national industries and firms at the national regional levels where the shocks of economic integration are initially felt. The national regional model departs from the conventional two-region core-periphery model (Krugman, 1991b) by inserting a third region, known to classical regional economists as an adjacent region, situated between the core and the periphery.

The CAP model allows for the identification of what Krugman (1991a) called multi-agglomerate or polycentric (Krugman and Venables, 1995) production structures within a country. The CAP model is a significant contribution to the study of national regional manufacturing concentration since it facilitates the analysis of the effects of the endogenous forces of trade liberalisation on regional manufacturing structure and concentration (Forslid et al., 1999, Krugman and Venables, 1996, Davis and Weinstein, 1998, 1999). The CAP-model is readily extended to a multi-region model of CAP clusters, where each cluster consists of adjacent and periphery regions around a single core region. CAP clusters reveal the multi-agglomerate production structure within a country.

Since the CAP model is a national regional model, in contrast to a national geographic model (as found in the empirical literature – Brülhart and Torstenson, 1996, Haaland et al., 1999, Forslid et al., 1999, Midelfart et al., 2000), it has necessitated the development of a new regional industry concentration measurement. We name this new measurement the ‘manufacturing labour-land concentration ratio’, which simultaneously reveals relative and absolute regional industry concentration. The CAP model, combined with the new regional manufacturing concentration ratio, permits an examination at the regional level, of the empirical outcomes found in the literature on the national aggregate levels.

The empirical literature finds that industries requiring a high degree of internal returns to scale will locate in the core regions, while firms with a low product demand elasticity and high levels of unexploited economies of scale will be more dispersed (Brülhart and Torstenson, 1996). Haaland et. al. (1999) have found that the localisation of expenditure in the home market and the need for input-output structures are determining criteria for industry concentration. Davis and Weinstein (1998; 1999) find that industries with high economies of scale located in the core regions are able to satisfy idiosyncratic (export) demand. Forslid et.al., (1999) find that reductions in trade barriers lead industries dependent on economies of scale and input-output linkages to relocate to the core regions, while industries dependent on the forces of comparative advantage and specialisation locate in the periphery regions.

In a definitive empirical study of changes in industry location, ex ante and ex post EU 1992, Midelfart et al.,(2000) combine industry characteristics with country location. Like Davis and Weinstein (1999) in their study of Japanese prefectures, Midelfart et.al.,(2000) find that industrial structures of central countries are characterised by high returns to scale technology and a highly skilled labour force. Periphery countries are found to have industries with low returns to scale, low technology, and a less skilled labour force. The authors also combine country characteristics with industry characteristics to find that central countries with a highly skilled labour force and high wages attract high technology, medium returns to scale, and capital-intensive industries. Periphery countries, on the other hand, with low wages attracted industries with low to medium returns to scale.

Midelfart et.al., (2000) find a growing divergence in the production structure of EU countries indicating greater country specialisation. The marginal decline in concentration of the overall manufacturing sector and the changing spatial concentration patterns over time is attributed to the increased EU manufacturing shares in the Southern European countries. Finally, Midelfart et. al.,(2000) find strong empirical results that location of industry across the EU is determined by the interaction of industry and country characteristics. These results underpin the theory of industry location on the basis of comparative advantage and new economic geography forces.
This study examines the movement of firms ($n$) and manufacturing labour ($L$), set in motion by the forces of EU trade liberalisation (reduction in ice-berg transportation costs, $t$), to bring forth absolute and/or relative manufacturing concentration in the Spanish regions. The analysis is conducted at the national regional geographic level in accordance with the framework of the CAP model, instead of the more conventional aggregated national core periphery (CP) model (Krugman, 1991b). Regional level analysis is significant since it allows for an examination of the results of endogenous forces (black box) of economic geography on the micro-economic behaviour of firm and industry location at the regional levels.

The paper consists of eight sections. Section 2 provides a brief discussion motivating the choice of Spain for this analysis. Section 3 develops the national regional CAP model. Section 4 chronicles the data sources for this analysis, criteria, methodology, and regional classification outcome. In section 5, the stylised facts of industry and employment changes are presented. In section 6, the similarity/diversity of regional industry structures is analysed using Krugman’s (1991a) industry index. In section 7, the relative and absolute manufacturing labour – land ratio is developed and applied empirically to manufacturing location in the regions of Spain. Conclusions of the paper are found in section 8.

2 Industry Location in Spain

Spain is of particular interest for an evaluation of the economic geography effects activated by EU trade liberalisation for a number of theoretical and empirical reasons.

First, Krugman and Venables (1990) classified Spain as an EU geographic periphery region. A theoretical trade liberalisation model examined economic development in Spain through the interaction of agglomeration and dispersion forces with the larger EU geographic core. The authors concluded that it remains ambiguous whether the pull of the home market effect of the geographic core will outweigh the competition effect of the geographic periphery.

Second, trade liberalisation in the EU reduces market access costs to transportation costs. Under the assumptions of imperfect competition and perfect domestic labour mobility, agglomeration and dispersion forces within Spain ensure the endogenous location and concentration of manufacturing industries in those Spanish regions whose size and geographical location provides access to domestic and foreign core regions (Krugman, 1991b; Davis and Weinstein, 1999). In the west, Spanish regions border on Portugal, while in the northeast its regions border on southern France. The well-developed infrastructure along the northern Mediterranean coast from Spain to Italy provides a low cost market access route to the EU geographic core for the geographically located competitive eastern Spanish regions.

Third, Spain’s southern geographic location, its resource endowments, and its relative wage and cost advantage (Krugman and Venables, 1990; Venables, 1994) versus the EU geographic core, exert an attraction force for manufacturing investment (Venables, 2000). The new economic geography theory predicts that Spain can expect not only to attract industries with low product demand elasticities and high levels of unexploited economies of scale (Krugman, 1991b; Haaland et. al., 1999; Midelfart et. al., 2000), but also industries seeking to take advantage of strong intra-industry linkages, in regions with an abundance of low cost skilled/unskilled labour to realise their competitive advantage (Krugman and Venables, 1995; 1996; Forslid and Wooton, 1999; Forslid, et. al., 1999; Midelfart et. al., 2000).

Fourth, research into Spain’s economic development is also prompted by the empirical work of Midelfart et. al., (2000), who find that ‘the spatial distribution of European manufacturing appears to be driven by developments in Southern Europe.’ The authors find that as Southern European countries increased their share of European manufacturing, EU manufacturing became more dispersed during the 1980s and 1990s, which contributed to the increased spatial clustering of manufacturing. These outcomes suggest a strong geographic competition effect in Spain that outweighs the agglomeration effect of the geographic core. The findings also support the self-sufficiency theory of Venables and Limao (2002)

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1 Baldwin et. al., (2002)
based on a country’s location, endowment of primary factors of production, commodity characteristics of transportation intensity, and factor endowments.

By way of summary then, theoretical arguments and empirical findings suggest that EU wide economic integration would have a significant effect on the regional location of Spanish manufacturing production activity. The free interregional mobility of the Spanish labour force, combined with low domestic transportation costs, will fuel regional home market effects through agglomeration forces (Krugman, 1991b; Davis and Weinstein, 1999). Spain’s geographic periphery status, with its relatively low wages, and abundance of natural resources, can be expected to attract capital investment due to its potential relatively higher rate of return versus the geographic core. The competition effect should lead to higher levels of investment to acquire economies of scale, resulting in capital stock accumulation, higher employment levels, higher wages, and a convergent production outcome relative to the EU geographic core (Venables, 2000).

3 A National Regional Core, Adjacent, Periphery (CAP) Model

The objective of this section is to develop a simple three-region geography model to classify a country’s administrative regions into Core, Adjacent, and Periphery (CAP). The significance of the model is threefold. First, it provides an empirical framework for analysing the forces of agglomeration and dispersion at the national regional levels where the shocks of economic integration – such as low priced imports – are initially felt (Krugman and Venables, 1990). Second, the model is easily extended to a multi-region CAP model. This is significant in so far that a country can have multiple core regions and, hence, a cluster of CAP regions. Third, the CAP model presents an alternative industry concentration measurement, applicable at the regional level. These three issues are examined in the subsequent sections. This section is divided into three parts. The first part focuses on the seminal theory of regional economists that underlies the geographic dimension of the (CAP) model. Part two, is a diagrammatic depiction of the CAP model, and part three provides the mathematical underpinning of the model.

3.1 Development of the National Geographic CAP Model

The development of the geographic CAP model employs two traditional themes of regional economics. The first, is von Thünen’s (1842) concentric circle theory of cultivation. The second, is the theoretical nomenclature developed and used by regional economists to describe region types (Paelinck and Nijkamp, 1975). The CAP model is a synthesis of these traditional lines of thought.

The geographic dimension of the CAP model differs from the Venables and Limao’s (2002) Heckscher-Ohlin-von Thünen model in a number of ways. One, the CAP model is a national regional geography model and not a multi-country model. Two, the CAP model is a seamless geographic world of regions and not of ‘disconnected’ countries. Three, the CAP model assumes interregional labour mobility. Four, the CAP model provides a framework for measuring the endogenous forces of economic geography in a world of imperfect competition. The similarities that exist with Venables and Limao (2002) pertain to; one, the inverse relationship between distance from the core and the income received for production activity; and, two, the appropriate analytical framework provided by the CAP model to examine the ‘interaction of two types of [region] characteristics with two types of commodity characteristics.’

3.1.1 Theory

Von Thünen’s (1842) concentric circle theory of cultivation locates production activity across three geographic areas consisting of a populated urban area that serves as the manufacturing and consumption core, and a first and second ring of regions where agricultural production is located. Von Thünen’s model proves that the transportation costs of market access reduces the level of rental income in direct relation to the distance between the location of production activity and the core region. The further
production activity is located away from the core region, the lower will be the level of wages and incomes received.  

The nomenclature of national administrative regions is found in the seminal theoretical literature of regional economists. Their theory of regional and interregional growth processes originated with the concept of the growth centre (Perroux, 1955), the centre-periphery theory (Pottier, 1963), and Klaassen’s (1967) attraction theory. The uniform theme of these theoretical models is that the centre region functions as an attraction region for interregional economic activity through the existence of transportation and communication costs. The centre attracts or disperses economic activities from or to the surrounding regions. The regional nomenclature developed for theoretical and empirical regional analysis classifies the administrative regions into polarised, contiguous, periphery, and natural regions (Paelinck and Nijkamp, 1975).

3.1.2. A Nomenclature of the Regions

A polarised region is a region “… that consists of economic interdependencies between economic and spatial elements.” The economic element is manifested by a high degree of external economies, and intersectoral commodity and factor flows. The spatial element refers to traffic, transportation, and communication structures. The degree of polarisation depends on the intensity and integration of all economic activity within the region. It can be characterised as being a singular physical area with an interwoven pattern of economic activity between industrial sectors reflecting forward and backward linkages. It is defined by the spatial integration of interdependent heterogeneous production activities, which create structural (compositional) inter-industry differences between these types of regions, resulting in regional income disparities.

A contiguous region is defined as a region that is adjacent to, and borders on, a polarised region. It possesses an economic structure that is dependent on that of a polarised region. Furthermore, a contiguous region is an administrative region with intersectoral and interregional input-output linkages to the polarised region. However, the level of economic activity in the contiguous region is weaker than that in the polarised region (Paelinck and Nijkamp, 1975). This is a crucial point, since it means that it cannot be assumed a priori that regional classification will automatically result in the defining of autonomous core and periphery regions. The existence of a contiguous region with an input-output linkage to the polarised region, introduces a third region type located between the polarised and periphery regions, providing a seamless geographic continuum in their totality.

Regional economists note that a periphery region is an outlying region and, as its name suggests, geographically distanced in space from a polarised region. The spatial geographic location of a periphery region is such that intersectoral and interregional economic linkages between it and a polarised region are not strongly developed. Krugman (1980, 1991a, 1991c, 1991d) has described a periphery region as “a geographic area with a low population density, consisting mainly of farmers, and a small share of manufacturing labour vis-à-vis the polarised region.”
A natural region is typified by geographical and physical characteristics such as climate, soil conditions, land fertility, height above sea level, and geographic location in space. The economic activities associated with natural regions include agriculture, forestry, mining, shipbuilding, and tourism. A natural region is relevant for determining the optimal spatial dispersion of agricultural production, in order to minimise the transportation costs of agricultural products. Forestry and mining are fixed natural resource endowments, while shipbuilding is located along coastal waterways. A natural region exhibits wide population dispersion with many small urban areas characterised by processing and local manufacturing industry and by low per capita income levels (Paelinck and Nijkamp, 1975).

The preceding discussion of region types leads to the following regional nomenclature used in this paper: a polarised region is a core region; and a contiguous region is an adjacent region. The nomenclature for the periphery region remains the same, and the term periphery includes the characteristics of the natural regions. This creates a three-region classification of national administrative region types that are superimposed on Von Thünen’s (1842) concentric circle theory. The advantage of this classification lies in the ease with which it facilitates the national and international comparison of the intensity of economic activity between comparable administrative regions.

3.2 A Diagrammatic Representation of the CAP Model

In Diagram 1, the concept of administrative regions is superimposed upon Von Thünen’s (1842) concentric circle model. The inner circle A represents the central urban area. Similarly, \( P_0P_1 \) and \( P_1P_2 \) respectively represent the distance of the first and second rings around the centre. This defines the concentric circles. The urban area A represents an administrative core region. Contiguous to the core region is an area whose administrative boundaries are indicated by \( bcde \). This area is an adjacent region which encompasses, for example, three urban centres, \( u \). This adjacent region falls within the first concentric circle ring. Juxtaposed to the adjacent region is a region, \( abef \), which falls in the second concentric circle ring. This region is a periphery region consisting of two small towns, \( t \). Jointly these three regions define the CAP model. Distance from the core to the periphery is represented by the radius \( P_0P_1P_2 \).

[Diagram 1]

The model is significant due to its ability to trace the domestic interregional economic effects of industry location and labour migration due to an external shock such as economic integration. The importance of the adjacent region is its distance to the core. Since it is geographically closer to the core than the periphery region, its proximity enhances its locational attractiveness. In this respect the CAP model distinguishes itself from the conventional country level core periphery model, such as in the empirical work of Forslid et al., (1999) and Midelfart et al., (2000), where firms relocate either from the outer core to the inner core or vice-versa and from the core to the periphery or vice-versa. The adjacent region eliminates this gap. Any wage differential, between the core and the adjacent region, increases the attractiveness of this region for industry location, while retaining profitable access to the core region.

3.3 The Mathematics of the CAP Model

Let \( U \) represent any country with a set of urban population density elements \( upd_i \), where \( i = 1, \ldots, I \). This set of population density elements is represented by:

\[
U = \{upd_i | i = 1, \ldots, I\}
\]  

(3.1)

where \( i \) is the urban population density of a given urban area, and \( I \) is the total of all urban areas in a country. It is possible to create three proper subsets of \( U \), with the symbols \( C, A, \) and \( P \), such that \( C \subset U, A \subset U, \) and \( P \subset U \), given the condition that \( C \neq A \neq P \neq U \). By using the extension theorem of integration situation, their economic development is contingent upon their industrial structure, and trade with foreign regions. Therefore, it would thus be erroneous to assume a priori that all peripheral regions have the characteristics of natural regions.
set theory, specific values of the elements from $U$ can be assigned to the three respective subsets: $C$, $A$, and $P$. Let the function $f(upd_i)$ be the criterion for the subset $C$, such that $f(upd_i) \in C$. Subset $C$ is then characterised by the following condition:

$$\varphi(upd_i) \in C \iff upd_i \in U \cap \varphi(upd_i) \quad \forall i \quad (3.2)$$

Thus each element $upd_i$ in $U$ that satisfies the criterion $f(upd_i)$ is assigned to the subset $C$. For subset $A$ and $P$, the criteria are $?\varphi(upd_i) \in A$, and $?\varphi(upd_i) \in P$, and is characterised by the following equation:

$$\gamma(upd_i) \in A \iff upd_i \in U \cap \varphi(upd_i) \cap \gamma(upd_i) \Theta_{CA} \quad \forall i \quad (3.3)$$

Equation (3.3) states that every element $upd_i$ in $U$ that satisfies the criteria $?\varphi(upd_i)$ will be assigned to the subset $A$. Finally, the criterion for subset $P$ is the same as for subset $A$ since a region that is two regions removed from the core can theoretically have the same $?\varphi(upd_i)$ as an adjacent region. However, it is differentiated from an adjacent region by its geographic location and lies in the second ring of regions around the core. The distance criterion is incorporated in equation (3.4) indicating that the distance between the core and adjacent regions, $?\Theta_{CA}$ is less than the distance between the core and the periphery regions, $?\Theta_{CP}$. This also implies that the distance between a periphery and an adjacent region $?\Theta_{AP}$ is less than the distance between the core and periphery regions, such that $?\Theta_{CP} > ?\Theta_{AP}$.

$$\gamma(upd_i) \in P \iff upd_i \in U \cap \varphi(upd_i) \cap \gamma(upd_i) \Theta_{CP} \geq \Theta_{AP} \quad \forall i \quad (3.4)$$

The extension theorem holds only if the following conditions are met. If $f(upd_i) \rightarrow C \cup (A \cup P) = U$, $?\varphi(upd_i) \rightarrow A \cup (C \cup P) = U$, and $?\varphi(upd_i)$($?\Theta_{CP} > ?\Theta_{CA} = ?\Theta_{AP}$) $\rightarrow P \cup (C \cup A) = U$, then:

$$\exists \quad C \cup A \cup P \Theta_{CP} \geq \Theta_{AP} = U \quad \forall i \quad (3.5)$$

and

$$\exists \quad C \cap A \cap P \Theta_{CP} \geq \Theta_{AP} = \emptyset \quad \forall i \quad (3.6)$$

The regions are disjoint because of the urban population density – and distance criteria assigned to each subset of regions. The regions are individual non-overlapping units bordering on each other in the order as given by equation (3.6). The universal set of regions can be rewritten as follows:

$$U = \bigcup_{j=1}^{J} R_j \quad \forall i \quad (3.7)$$

Then one may write,

$$U = \bigcup_{j=1}^{J} R_j = C \cap A \cap P \Theta_{CP} \geq \Theta_{AP} = \emptyset \quad \forall i \quad (3.8)$$

For any country, $U$, the union of its regions is a disjoint universal set. The union of the regions is a collection of a number of core, adjacent, and periphery regions that are non-overlapping as defined by the extension and distance criteria of set theory. This is expressed in the following equation;

$$U = \bigcup_{j=1}^{J} R_j = \sum_{j=1}^{C} C_j \cap \sum_{j=1}^{A} A_j \cap \sum_{j=1}^{P} P_j \Theta_{CP} \geq \Theta_{AP} = \emptyset \quad (3.9)$$
This equation states, that for any country $U$, the union of its administrative regions is equal to the sum of its economics regions; core, adjacent, and periphery. These regions form a non-overlapping collective. This model serves as a framework to study the dispersion of economic activity within the geographic confines of a country.

The multi-region CAP model is defined as follows:

$$\text{CAP}_j = C_j \cap \bigcap_{j=4}^{A_j} A_j \cap \bigcap_{j=1}^{P_j} P_j (\theta_{CP} \geq \theta_{CA} \geq \theta_{AP}) = \emptyset$$

(3.10)

where $\text{CAP}_j$ represents a core, and a cluster of $j$ adjacent, and periphery regions. These region types are symbolised by: $C_j$ core, $A_j$ adjacent, $P_j$ periphery. Distance from the core is represented by the symbol $\theta$. The expression in brackets states that the distance from the core to the periphery $\theta_{CP}$ is greater than the distance from the core to the adjacent $\theta_{CA}$, and the distance from the adjacent to the periphery $\theta_{AP}$ is greater than, or equal to the distance from the core to the adjacent. The symbol $\emptyset$ indicates that the regions are non-overlapping.

The multi-region CAP model is called a CAP cluster. The number of first and second ring regions around the core agglomerate determines the number of regions in the cluster. For example, if a core agglomerate is contiguous to one adjacent and one periphery region such that $j = 1$ for both $A_j$ and $P_j$, this results in a basic three-region CAP cluster. On the other hand, if a core region is surrounded by three adjacent regions and two periphery regions, then $A_j = 3$, and $P_j = 2$, this would provide us with a six-region model, with economic interaction occurring between the regions due to their geographic proximity.

A multi-region country $U_i$ can consist of a number of $\text{CAP}_j$ clusters, each with a varying number of regions. An individual country is the sum of its $\text{CAP}_j$ clusters, expressed as follows:

$$U_i = \sum_{j=4}^{\text{CAP}} \sum_{j=4}^{A_j} A_j \cap \sum_{j=1}^{P_j} P_j (\theta_{CP} \geq \theta_{CA} \geq \theta_{AP}) = \emptyset$$

(3.11)

Where, country $U_i$ is the sum of it $\text{CAP}_j$ clusters. For example, Spain has the three CAP clusters of Pias Vasco, Madrid, and Cataluna, with each cluster consisting of a different number of regions. This would typify a national multi-agglomerate production structure.

The multi-region CAP model ceases to exist in two cases. First, when the regions in a country do not meet the adjacent and/or periphery region criteria; it is entirely possible that a country consists of a collection of regions where each adjoining region meets the core region criteria. This results in a geographic area of contiguous densely populated regions or agglomerates. An example of this would be the collection of core regions in the German provinces of Baden-Württemberg and Bayern. Second, the model is not applicable when a country has no periphery regions. In this instance, the adjacent region would become the growth region, as would be the case in Belgium.

The core regions within a country represent a central geographic location of concentrated production activity. These regions attract or disperse economic activity. If the core is an attraction region, the agglomeration forces pull economic activity from the adjacent and the periphery regions, to the core as a result of higher wages. Conversely, if the core is a dispersion region, the competition effect will push economic activity in the opposite direction. That is, if the cost of production in the adjacent and periphery regions is relatively lower than in the core region i.e. a wage differential, the core becomes a dispersion region.

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8 Each CAP cluster is a union of administrative regions around a core region that form a non-overlapping collective.

9 See Brand, (2003)
The CAP model postulates that the pre-integration regions in the CAP clusters are asymmetrical. Manufacturing is not equally distributed over the regions, but instead the CAP model indicates a sequentially declining manufacturing concentration from the core to the periphery. The model also assumes, by definition of the regions, that the regional concentration of agricultural production is the inverse of manufacturing concentration. This means that agricultural imports to the core are subject to transportation costs, resulting in an upward sloping factor input supply curve that will eventually mitigate the forces of agglomeration in the core regions (Krugman and Venables, 1990).

Theory (Krugman, 1991b) postulates that the economic dynamics (gradually declining trade costs) released by the forces of trade liberalisation will initially impact the core agglomerates, and subsequently or simultaneously affect the lower cost adjacent and periphery regions (Forslid, et al., 1999). Reduced market access costs affect a firm’s (industry’s) geographic location decision. Together with an improved domestic infrastructure, reduced transportation costs, would encourage the relocation of firms away from the core that are: i) not dependent on strong input-output structures, ii) and/or have low demand elasticities, iii) and/or wish to relocate to lower cost regions, to enhance their comparative advantage position. This implies a movement of production activity along a radius extending outward from the core as the CAP model postulates.

4 Data, Criteria, Methodology, and Classification Outcome

4.1 Geographic and Demographic Data

4.2 Industry Data

The study examines 23 industry branches per region at the NACE 2 digit level. The industrial sectors and their industry branches are listed in Table A.1 in the Appendix. The industry structure in Spain is subdivided into the sectors Energy, Extraction and Processing, Engineering, and Other Manufacturing as found in the Eurostat (1993) publication, The Structure and Activity of Industry; Data by Regions 1988/89, Theme 4, Energy and Industry. The sector Energy consists of the public utility companies, and the extraction and processing of energy materials. The sector Extraction and Processing is composed of industries that extract and transform non-energy-producing materials. The sector Extraction and Processing is composed of industries that extract and transform non-energy-producing materials. The sector Engineering consists of metal manufacturing industries as well as mechanical, electrical and instruments engineering. It represents the supplier firms of intermediate products and forms the source for external economies of scale through backward linkages for final goods producers. Finally, the sector Other Manufacturing includes the final goods supplier industries, and creates forward linkages for the intermediate goods producers.

4.3 Region Classification Criteria
In their Labour Force Survey of 1998, Eurostat11 introduced the concept of regional urbanisation. Three types of regions are defined according to their degree of urbanisation. A densely populated region is one where one or more urban areas have a population density of more than 500 people per square kilometre. The region may also contain other urban areas with a lower population density. An intermediate

10 NUTS is Eurostat’s acronym for ‘Nomenclature of Territorial Units for Statistics’.
11 Eurostat, Statistics in Focus: Regions, 1998 (4)
A region is one that is composed of one or more urban areas with a population density of more than 100 people per square kilometre, [but less than 500 per square kilometre, and borders on a densely populated region]. A region with a low population density is characterised as having less than 100 people per square kilometre.

This study uses the Eurostat urbanisation criteria for regional classification purposes. A core region is defined as a region with one or more urban areas with a population density greater than 500 people per square kilometre. Such an urban area is called an urban agglomerate. The term, adjacent region, refers to those regions, which border on core regions, and that have one or more urban areas with a population density greater than 100 people, but less than 500 / km². Finally, a periphery region is a region bordering only on an adjacent region or another periphery region. Furthermore, a periphery region can have one or more urban areas with a population density less or between 100 and 500 people per square kilometre.

4.4 Methodology

The CAP model postulates that a core region can be surrounded by a first-ring of adjacent regions, and a second-ring of periphery regions. The number of adjacent and periphery regions in a cluster can vary depending on the dispersion and density of urban agglomerates. A CAP cluster $j$ is defined in equation (3.10) as follows:

$$ CAP_j = C_j \cap \bigcap_{i=1}^{\gamma} A_i \cap \bigcap_{i=1}^{\gamma} P_i(\theta_{cr} > \theta_{cs} \geq \theta_{up}) = \emptyset $$

(3.10)

To obtain a three-region CAP model, assume that $j = 1$, and rewrite equation (3.10) to include the regional criteria as follows:

$$ CAP_j = \gamma(upd_j) \in C_j \cap \gamma(upd_j) \in A_i \cap \gamma(upd_j) \in P_i(\theta_{cr} > \theta_{cs} \geq \theta_{up}) = \emptyset $$

(3.10a)

Expression (3.10a) defines a three-region CAP model consisting of one core, one adjacent, and one periphery region. The hierarchical link between the regions is determined by the population density and distance criteria. The subscripts $i$ refer to the number of urban areas in the respective regions.

The classification procedure uses the urban population density criteria for the cities in the Spanish administrative regions. The regions are classified into core, adjacent, and periphery based on the urban population and the distance criteria. The region types are identified by the symbols $R(x,y)$, where $R$ refers to region type: C, A, and P, $x$ indicates the regions population criterion, and $y$ represents the number of urban areas in the region that meet the required criterion.

4.5 Empirical Outcomes of Spanish Regional Classification

The Spanish regions are classified according to the urban population density criteria as described in section 4.3. The CAP clusters, as listed in Table 1, are determined by the population density $\gamma(upd_j)$, and the distance criteria, $\gamma$, using equation (3.10a). The regional classification outcome identifies three core regions, eight adjacent regions, and two periphery regions.

[Table 1]

Spain has three core agglomerates, each of which is surrounded by adjacent regions in the first-concentric circle, and one or more periphery regions in the second-concentric circle. This outcome means that Spain is characterised by a multi-agglomerate production structure (Krugman, 1990).

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12 Author’s insertion and modification.
13 Eurostat definition.
5 Stylised Facts: Industry Location and Employment Changes

5.1 Regional Changes in the Number of Firms, (Δn).

In the new economic geography theory, trade liberalisation brings about an endogenous relocation of firms and industries (Krugman, 1991b) to larger markets where other industries have located before them (Venables, 1994). Empirical research at the country level (Brühlhart and Torstensson, 1996; Forslid et. al., 1999; Midelfart et. al., 2000) and at the regional level (Davis and Weinstein, 1999) has corroborated these theories.

The new economic geography theory of industry location can be applied to the micro-regional framework of the CAP model. In this model, trade liberalisation is expected to eliminate inefficient firms and increase the number of new firms and/or industries in the core agglomerates of Spain (Pias Vasco, Madrid, and Cataluna) where firms in similar industries already exist (Krugman, 1991b; Venables, 1994; Krugman and Venables, 1996).

This section examines three issues concerning the entry of new firms between 1989 and 1997. First, which region type has experienced the largest increase in new firms? The new economic geography theory (Krugman, 1991b) would predict the ‘home’ market effect to dominate in the core regions revealing increases in the number of new firms, population, and labour. Second, how are the new firms distributed over the regions in the CAP clusters? This question addresses the issue of whether similar firms in an industry locate in similar region types. Three, how are the new firms distributed sectorally in the CAP clusters? The outcome to this question will reveal the clustering behaviour of intermediate and final goods producers in a common region or adjoining regions, thereby affecting regional industry composition (Krugman and Venables, 1996).

First, the effects of trade liberalisation on industrial structures in the respective CAP clusters reveals a net loss of firms in the clusters of Pias Vasco and Madrid as is illustrated in Table 2. The CAP cluster Cataluna shows a net increase in industry location.

The core regions of the respective clusters experienced the largest increase of new firm location. The data reveals a growth of firms in the core regions of Cataluna (Δn = 12,840), Madrid (Δn = 6,578), and Pias Vasco (Δn = 1,593) The three core regions show an absolute increase in new firms in the four industry sectors, with the exception of the Energy sector in Pias Vasco. Together the core agglomerates experienced an increase of 21,011 new firms.

Within each of the CAP clusters, all of the adjacent regions experienced a considerable growth in the number of new firms across all industry sectors. The most significant increase occurred in the adjacent region of Comunidad Valencia (Δn = 8,734) that borders on the core region of Cataluna in the east, followed by the adjacent regions (Δn = 1,700) surrounding the core region of Pias Vasco in the west, and in the adjacent regions of Madrid (Δn = 1,416). The adjacent regions combined experienced an increase of 11,850 new firms. The periphery regions experienced an increase of 4,252 new firms.

These empirical results on industry growth in all three-region types reveal both the effects of agglomeration and dispersion forces. Industry growth in the core regions is almost double the growth in the adjacent regions, while the latter experienced more than twice the growth of industry than in the periphery regions. The outcome verifies Von Thünen’s (1823) concentric circle theory of the CAP model that industrial concentration declines with increased distance from the core revealing the significance of the adjacent region in providing a spatial geographic continuum for manufacturing location between the core and the periphery.

[Table 2]

The CAP cluster of Cataluna, in the east, experienced the largest increase in the number of firms in all four industrial sectors. The 22,510 new firms in this cluster represent 58% of all new firms in Spain. In the CAP cluster of Madrid, 10,837 new firms were established, which represents 28% of the total. In the CAP cluster of Pias Vasco, there were 3,766 new firms or 10% of the total. Finally, the Island Periphery regions experienced an increase of 5%, which translates into 1,920 new establishments. All three of the CAP clusters reveal an increase in the number of firms in their core regions, as well as in their adjacent and periphery regions. The data-table containing these results is available from the author upon request.
The second question examines the distribution of new firms across the regions in the CAP clusters. In the conventional core periphery model relocation of firms is restricted to a core or a periphery region. Forslid et al. (1999) argue that with the reduction of trade barriers firms relocate from the outer core to the inner core and/or from the core to the periphery depending on their need for internal- and external economies of scale, the demand elasticity of their product and the need for skilled or unskilled labour. The national theoretical construct (Krugman, 1991b) of the core periphery model makes no allowance for an adjacent country. At the regional geographic level, the adjacent region is a region that by definition attracts firms with strong forward and backward linkages to the core region. The distribution of new firms across CAP regions should reveal which types of industries are locating in which particular types of regions.

The regional distributions of new firms within the relevant CAP clusters, over the period 1989 to 1997, are shown in Table 3.

[Table 3]

In general, the regional distribution of firms within the CAP clusters is not uniform. There is no observable consistent pattern across the industry sectors of new firms being attracted to the core regions. Only the industry sector Engineering reveals a consistent pattern of new firms establishing themselves in the core regions as is also found by Forslid et al. (1999) and Midelfart et al. (2000). These industries include: basic metal products, fabricated metal products, machinery equipment, office machinery and computers, electrical machinery and apparatus, medical precision instruments, motors and trailers, and other transports. Each CAP cluster shows a different pattern. Davis and Weinstein, (1999) have also found these industries to show strong economic geography effects, relying on increasing returns to scale and favouring home market locations.

In the CAP cluster of Pias Vasco, there is a proportionately higher distribution of firms to the adjacent regions while in the CAP cluster of Madrid there is a relatively higher distribution to the periphery\(^\text{15}\) (\(n = 2,843\)) than the adjacent regions. The CAP cluster of Cataluna also shows a high distribution of firms to the adjacent regions, in particular the adjacent region of Communidad Valencia. More importantly, however, the data shows that firms in similar industrial sectors will locate in anyone of the three region types. This seems to suggest that region characteristics are less important than the characteristics of existing industries. The data appears to suggest no correlation between industry and region characteristics (Midelfart et al., 2000).

The distribution patterns of the new entrants may be due to initial ‘high’ or ‘low’ regional industry shares (Krugman and Venables, 1996; Midelfart et al., 2000). It is evident from the calculation of regional initial ‘high’ or ‘low’ shares, and their changes between 1997 and 1989, that the core region of Cataluna and its adjacent region of Communidad Valencia, in general, have the relative highest levels of similar industry shares in Spain. The data reveals that more than 90% of new firms in the CAP cluster, Cataluna, locate in the core agglomerate and its adjacent regions. The choice of region type by these firms could be motivated by the need for intra- and inter-industry linkages, as argued by Paelinck and Nijkamp (1975), and proven by Midelfart et al. (2000), whose research finds the need for strong forward and backward linkage between certain industries. This outcome, once again, indicates that the home market effect, the competition effect, and cumulative causation influences firm’s location decisions (Krugman, 1991b; Venables, 1994). The adjacent region, in accordance with its concentric circle definition, appears to be serving its geographic function for the core agglomerate, creating potentially strong intersectoral and interregional industrial economic relationships between the two region types (Paelinck and Nijkamp, 1975).

The third question concerns the sectoral distribution of new firms within the CAP clusters. Do intermediate and final goods industries cluster, as Krugman and Venables (1996) have argued, in a

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\(^{15}\) The two periphery regions are Extremadura and Andalucia. Extremadura is an inland border region with Portugal geographically located on a radius between the core regions of Madrid and Lisbon and serves as a trade conduit from Portugal to eastern Spain. Andalucia is a southern coastal periphery region. It has three urban areas whose population densities are larger than 100 but less 500 people per square kilometre. It has the largest relative number of urban areas and total population of the Spanish regions.
common region to reap pecuniary agglomerate advantages through external and internal returns to scale? Insight into this question is gained from the information in Table 3. As noted, the Engineering sector reveals a consistent growth pattern in the core regions of the three CAP clusters. With the exception of the core region of Pias Vasco, the final goods industry (represented by Other Manufacturing) reveals a growth pattern in the core regions of Madrid and Cataluna commensurate with the growth of the Engineering industry. This outcome would seem to support the theory of Krugman and Venables (1996) that intermediate and final goods industries cluster in similar regions thereby changing the regional industrial structure.

It is also of significance to note the substantial growth of the Engineering and Other Manufacturing sectors in the core and adjacent regions of the Pias Vasco cluster. A possible explanation is industry development starting from initial ‘low’ industry shares. Combined, these two industrial sectors suggest a growth of upstream and downstream industries creating an economic climate for potential agglomeration forces in this CAP cluster (Krugman and Venable, 1996).

The analysis of regional industry growth has revealed that agglomeration forces compelled the largest number of new firms \( (n) \) to locate in the core agglomerates. The competition force dispersed the remaining firms to the adjacent and periphery regions. The reason for the distribution of firms to specific regions needs to be found in the characteristics of both the firms and the regions in which they located. There appears to be a strong location relationship between upstream and downstream industries suggesting mutual interdependencies in the form of intra and/or inter-industry linkages.

5.2 Manufacturing Employment, \( (\Delta L) \)

The new economic geography theory (Krugman, 1991b) argues that labour \( (L) \) is interregionally mobile and will migrate to regions in search of higher wages. The restructuring of Spanish industry, post EU 1992, resulted in the exit and entry of new firms. The exit of firms led to regional unemployment and an excess labour supply, while the entry of new firms increased the demand for labour. The stylised facts of this section focuses on the effects of the restructuring of Spanish industry on manufacturing employment. It seeks to answer the following questions. First, in which industrial sectors did the rationalization of production generate the largest loss of manufacturing employment? Second, which industrial sectors and industry branches created new employment opportunities? Third, is there a relationship between the entry of new firms into industry branches and the creation of new employment opportunities? Fourth, how have regional industry structures changed due to greater trade liberalisation? This final issue is examined in a separate section using Krugman’s (1991a) Industry Index.

5.2.1 Employment Relocation\(^{16}\)

Labour force relocation is revealed through changes in employment positions – losses and creations. We are interested in answering the question, ‘In which industrial sectors did the rationalization of production generate the largest loss of manufacturing employment?’ The data in Table 4 reveals a net outflow of labour from the Energy and Other Manufacturing sectors, while the Extraction and Processing, and Engineering sectors show a net increase in employment creation. An examination of the CAP clusters in Table 4 shows the geographic relocation of manufacturing employment.

\[ \text{Table 4} \]

The largest loss of manufacturing employment occurred in the CAP cluster of Pias Vasco. This cluster experienced a net loss of manufacturing employment that relocated to the CAP clusters of Madrid and Cataluna, both of which experienced a net increase in manufacturing employment.

\(^{16}\) The term ‘loss’ refers to a loss of manufacturing positions in industry branches in particular regions. The term ‘new’ refers to new employment opportunities in industry branches in other regions within the CAP cluster. For example, the CAP cluster of Pias Vasco experienced a loss 27,113 jobs in the Energy sector, while 498 new jobs were created in this sector but in different regions within the cluster. In this particular cluster, the new jobs were created in the adjacent region of La Rioja. In the CAP cluster of Madrid, 5,791 new jobs were created in the core region of Madrid, 250 in the adjacent region of Castilla La Mancha, and 302 in the periphery region of Andalucia. In the CAP cluster of Cataluna, 43 new manufacturing jobs were created in the Energy sector in the core region of Cataluna.
The distribution of employment over the industrial sectors within the CAP clusters reveals an outflow of manufacturing employment from the both the Energy and Other Manufacturing sectors. In total, the loss of employment positions exceeded the creation of new ones. The loss of employment in the Energy sector is consistently higher than the share of new jobs created in this industry for all three CAP clusters. The same trend is evident in the sector Other Manufacturing where the loss of manufacturing employment exceeds the number of the newly created employment positions except in the CAP cluster of Cataluna.

Since there was a net creation of new jobs between 1989 and 1997, we assume that this excess manufacturing labour has been reabsorbed through the creation of new jobs in the Extraction and Processing and Engineering sectors\(^{17}\) indicating both interregional and intersectoral labour mobility. The growth of the intermediate supplier industries, Extraction and Processing and Engineering, means a growth in their concentration and levels of production (as suggested in the empirical research of Midelfart et al., 2000) and the enhanced development of internal and external economies of scale (Krugman and Venables, 1996). This leads to the question, “In which region-types are employment opportunities in these industries increasing?”

5.2.2 CAP Cluster Redistribution of Employment

The distribution of the newly created employment positions within each CAP cluster is presented in Table 5 below.

<table>
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In the CAP cluster Pias Vasco relocation of employment in the Extraction and Processing industry occurred primarily in the four adjacent regions. The Engineering sector also exhibits a dispersion of new employment over all three-region types, with the highest share in the adjacent regions. Although the sector Other Manufacturing shows a net decline in new job creation, the employment opportunities that are created are concentrated in the adjacent regions with some relocation to the periphery region of Asturias.

In the periphery region of Asturias, the Engineering sector benefited from the creation of 3,739 new jobs – primarily in the industry branches fabricated metal products, and machinery equipment, industries normally located in the core regions (Forslid et al., 1999). In the Other Manufacturing sector, the same periphery region enjoyed the creation of 2,368 new jobs – primarily in food beverage and tobacco, textiles, and the paper and paper products industries. The growth in these two industry branches in the periphery region of Asturias accentuates the strength of the competition effect (Krugman, 1991b), the possible creation of new forward and backward linkages (Venables, 1994), and capital accumulation starting from ‘low’ initial levels to achieve economies of scale in production (Krugman and Venables, 1996).

In the CAP cluster Madrid, only 25.9% of the new employment opportunities in the Extraction and Processing sector occurred in the core region of Madrid. The remaining 74.1% is distributed almost equally over the adjacent and periphery regions, with almost the entire 40.3% being located in the periphery region of Andalucia, in the industry branch non-metallic minerals. In the Engineering sector, half (50%) of new employment opportunities occurred in the core region of Madrid, while 20.2% located to the two adjacent regions. It is significant that 29.5% of new employment opportunities in Engineering were located in the border periphery regions, once again reflecting the strong competition effect. Finally, the core and the adjacent regions of Madrid are the primary beneficiaries of new employment opportunities in the Other Manufacturing sector.

In the CAP cluster of Cataluna, the relocation of employment and the creation of new jobs occurred predominantly in the core and its adjacent regions. The 84.3% employment increase in the Energy sector reflects the creation of new jobs in the coke refinery and nuclear energy branch in the core region of Cataluna. In the Extraction and Processing sector, new employment opportunities occurred almost equally between the core region Cataluna (51.1%) and the adjacent region of Communidad Valencia (42.2%). The periphery region of Murcia experienced an increase of 6.7%.

\(^{17}\) This assumption is based on the theory of imperfect international labour mobility (Ludema and Wooton, 1997)
In the Engineering sector, the core region of Cataluna enjoyed a substantial relocation of employment and entry of firms in the intermediate goods producing industries in which the region enjoyed historical ‘high’ initial industry shares (Krugman and Venables, 1996). This is clear evidence of the clustering of intermediate goods producing industries and the cumulative causation process of agglomeration (Venables, 1994). Cataluna’s two adjacent regions also experienced a combined increase of 30.6% new jobs in the Engineering sector, with the largest increase of 15,814 new jobs occurring in the adjacent region of Commanded Valencia, and the remaining 7,200 going to Aragon. This dispersion of Engineering employment to the two adjacent regions around the core region of Cataluna, suggests the possible strong need for inter- and intra-industry linkages (Krugman and Venables, 1995). It is also, again, clear evidence of the working of the competition effect (Krugman, 1991b) in the CAP cluster of Cataluna.

In the Other Manufacturing sector, the increase in new employment creation is relatively more intense in the adjacent regions than in the core. In the core region of Cataluna, 41,733 new employment positions were created as opposed to the 48,217 in the adjacent regions. Of the approximate 46,000 new jobs created in Commanded Valencia, 34,900 occurred in the industry branch leather and leather products, giving the region a high share in that industry. The periphery region of Murcia also experienced a substantial increase of employment in the industry branches: – leather and leather goods (1,897), food beverage and tobacco (1,774), and paper and paper products (1,039).

The analysis of employment redistribution allows us to answer the question, “In which region-types are employment opportunities in the Extraction and Processing, and Engineering sectors increasing?” In the CAP cluster of Pias Vasco, these industries have located primarily in the adjacent regions. In the CAP cluster of Madrid, these industries appear to have concentrated in the core region of Madrid with dispersion to the adjacent and periphery regions. In the CAP cluster of Cataluna, these industries have located primarily in the core region with a high dispersion to the adjacent regions.

These outcomes indicate that both agglomeration and dispersion effects are contributing to the restructuring of manufacturing industry in the respective CAP clusters. However, the contribution of these forces appears to be differentiated depending on the geographic location of the CAP cluster. The most significant outcome is that the adjacent regions experienced strong employment creation in the Processing and Extracting, and Engineering sectors indicating the growth of an intermediate industry in these regions that provide forward and backward linkages with the core regions as theorised by classical regional economists.

5.2.3 Regional Industry Shares, Employment, and Economic Districts

This section answers the third question: ‘Is there a relationship between the entry of new firms into industry branches and the creation of new employment opportunities?’ There are regions that lost industry share, but experienced an increase in employment. The relation between industry share, labour demand, and new employment is illustrated in Table A.3 in the Appendix that shows the industry branches and regions that have enjoyed an increase in manufacturing employment.

All regional industries that experienced increased shares are identified by the symbol L (low), H (high), and C (relatively high shares), respectively. The establishment of new firms in a region is represented by the symbol N. Regional industries that experienced a reduction in shares, but an increased demand for labour have no symbols. For example, the adjacent region of La Rioja experienced an increased demand for labour in the industry branches electricity gas and steam, and in the purification and distribution of water, even though the number of firms in these industry branches declined. Regional manufacturing employment is also present in those industry branches that do not have an employment figure. Employment declined in these regional industry branches.

The industry share and employment data in Table A.3 provides tangible evidence of increased industry concentration through clustering, and cumulative causation (Venables, 1994; Krugman and Venables, 1996). The Extraction and Processing sector and the Engineering sector, show increased concentration in regions with initial ‘low’ and ‘high’ shares in industry sectors. The strongest effects are evidenced in the CAP cluster of Cataluna, in the core and its two adjacent regions. Industrial clustering occurred in industries with initial high shares (H), and in industries with extremely high shares (C). The
same clustering force is evident in the CAP clusters of Madrid, not only in the core agglomerate, but also in the border periphery region of Andalucia.

The effect of trade liberalisation on a border periphery region is underscored in by the strong cumulative causation outcome in the ex ante border periphery region of Galicia in the CAP cluster of Pias Vasco. This CAP cluster also has the largest number of industries starting from ‘low’ initial levels in both industrial sectors Extraction and Processing, and Engineering. There is significant employment creation in the regions of this CAP cluster where industries experienced a decline in their numbers, such as in the core region of Pias Vasco and the adjacent region of Galicia. This outcome suggests merger and consolidation activities of firms in the Engineering sector desiring to achieve economies of scale in production.

Krugman and Venables (1996) have argued that upstream and downstream industries will cluster in common locations to achieve external and internal economies of scale. Final goods producers will locate in the region that has a large base of intermediate goods producers, and vice versa. ‘A [region] with a strong initial position in some industry [sector] may find itself with an advantage that cumulates over time.’ The initial evidence in support of this theory is found in the sectoral distribution of new firms within the CAP clusters. The current data illustrates these dynamics in five Spanish regions where intermediate and final goods producers have found a common location. The border region of Galicia shows strong growth of both the Engineering and the Other Manufacturing sectors. In the CAP cluster of Madrid these dynamics are apparent in the core agglomerate as well as the adjacent region of Castilla La Mancha. The same is true for the core agglomerate of Cataluna and its adjacent region of Communidad Valencia.

The clustering of firms in similar industries, in the core agglomerates and their adjacent regions, suggest that industrial structures transgress the boundaries of administrative regions thereby creating economic regions with strong intra and inter-industry dependencies, as regional economists have argued (Paelinck and Nijkamp, 1975). These authors have noted that an adjacent region is an administrative region with intersectoral and interregional input-output linkages to the core region. These observations are supported by Lösch (1954) who writes that input-output structures are not by definition necessarily confined to one administrative region, but because of economic linkages, can extend beyond the borders of an administrative region to a different adjacent region. Krugman (1991a) supports the regional economists’ analysis. Economic structures may not simply be confined to an administrative region. Intersectoral and interregional linkages determine the size of economic input-output structures, and thus the extent of economies of scale. Krugman (1991a) states, ‘There is no reason to suppose that political boundaries define the relevant unit over which…external economies apply.’ The evidence seems to suggest that core and adjacent regions are creating economic districts within the respective CAP clusters. Adjacent regions appear to be development regions allowing the seamless expansion of industrial structures.

The answer to the question, of there being a relationship between the entry of new firms into industry branches and the creation of new employment opportunities, appears to be positive. The empirical evidence leads to the conclusion that trade liberalisation has stimulated employment growth within the economic districts of the CAP clusters. This is particularly evident in the adjacent regions of the core agglomerates Madrid and Cataluna. A similar conclusion can be drawn for the CAP cluster Pias Vasco where capital accumulation is in its developments phase. In the CAP cluster even industries in regions that experienced no industry growth exhibited increased demand for manufacturing labour indicating the spatial strength of the competition effect in generating new product and employment demand in existing industries.

The above observation is further supported by the characteristics of many of the industries involved in the growth process in Spain. Davis and Weinstein (1999) find strong economic geography effects of firms in the Engineering sector in the core agglomerates. Forslid et al., (1999) have found that industries in the Extraction and Processing, as well as in the Engineering sector are dependent on intermediate inputs and require high economies of scale. Further empirical evidence for this conclusion is

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18 Examples of increases in manufacturing employment (L) in regional industries experiencing no new firm locations are industries in the Engineering sector in Pias Vasco, or the Energy and Extraction and Processing sector in the adjacent region La Rioja.
found in Midelfart *et al.*, (2000) where the coefficients on interaction variables show that high tech industries locate in or near the core agglomerate because of their need for strong forward and backward linkages. Similar conclusions are drawn by Henriksen *et al.*, (2001) in a cross-country study of Germany, France, Italy and the UK for specific industry branches in the Engineering sector.

The preliminary outcome of employment relocation analysis is that manufacturing labour migrated not only to regions where new firms are being established, but also to those regions where existing industries experienced high product demand. Economic geography effects seem to be encouraged by low internal domestic trade costs and a mobile interregional and intersectoral labour force that reinforces the home market and competition effects (Davis and Weinstein, 1999). Trade liberalisation resulted in an apparent recomposition of industrial structures in the agglomerates of the CAP clusters (Krugman and Venables, 1996).

The initial analysis of trade liberalisation effects on firm location and labour migration appears to support the theoretical ‘black box’ dynamics of the endogenous location of industry. However, the outcome also accentuates the analytical value and significance of the framework of the CAP model in a number of ways. First, it clearly defines the geographic boundary and the size of core agglomerates. Second, it illustrates the working of the concentric circle theory that provides an uninterrupted geographic continuum of contiguous regions around the core. Third, it facilitates the examination of the geographic location aspects of industry concentration and/or dispersion. Fourth, it allows for the identification of regions with initial ‘high’ and ‘low’ shares of industry concentration. Fifth, it identifies the CAP clusters as measures of centrality revealing multi-agglomerate production outcomes.

The stylised facts analysis has revealed a relocation of firms and manufacturing employment within the CAP clusters, primarily in the core and adjacent regions. It is evident that Spain is characterised by a multi-agglomerate production structure. It is also apparent that there has been a change in the composition of industry structures within the CAP clusters. We now turn to the fourth question, ‘How have regional industry structures changed due to greater trade liberalisation?’ We examine the composition of regional production structures to assess whether there has been a convergence or divergence in industry structures within and between CAP agglomerates and adjacent regions.

### 6 Analysis of Regional Industry Structure: Similarity / Diversity

Krugman’s (1991a) regional industry index is employed to compare the increased similarity or diversity of industry structures between regions between the years 1989 and 1997. The industry index is constructed using regional industry employment data.

The Krugman industry index is calculated with the following statistic;

$$ I = \sum |s_{ij} - s_{ij}^*| $$

(6.1)

where, $s_{ij}$ is the share of industry $i$ in total manufacturing employment in region $j$ ($i \neq j$), and $s_{ij}^*$ is the regional share of manufacturing employment in the region with which the comparison is made. The industry index can take on a value from zero to two such that $0 = I = 0$. In those instances in which the industry structure in two regions is the same, (i.e. the share of employment in the respective industries is identical), the index value will be zero. Similarly, if the industry structures in the two regions are completely dissimilar, if the index value will be 2. Based on this method, the index quantifies the difference or similarity in regional industry structure, and hence regional specialisation.

The industry index is calculated for the Spanish regions in 1989, and again after economic integration in 1997. By comparing these values, the similarities or the differences between industry structures are rendered apparent. Furthermore, this comparison highlights similarities and differences

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19 They also find that Spanish industry has a need for relatively higher returns to scale and higher technology levels than the southern EU countries of Portugal and Greece.
between the core and adjacent regions, and non-adjacent regions *ex ante* and *ex post* economic integration. A pronounced similarity in industry structures, between non-adjacent regions, suggests a polycentric production structure, i.e. regions geographically removed from each other with similar industry structures. The significance of a polycentric production structure is, that it implies that ‘increased integration has not been sufficiently strong to destabilise the existing geography of production’ [20], and that industry is not concentrated in one geographic location, but instead, is dispersed.

6.1 **Industry Index for Spain**

The results of the analysis of the regional industry index for the two periods 1989 and 1997 are found in Table 6. The regions are listed in the left-hand column of the table. The reference regions are listed in the top row of the table. To make a comparison of regional values for 1989, one reads from left to right. The 1989 values are listed in the upper right hand portion of the matrix. These values indicate the similarity or difference in the regional industry structures in Spain during the period of the EU customs union before economic integration in 1992.

In contrast, the 1997 values are listed in the bottom left-hand portion of the matrix. These are the post-economic integration values. In this case, a comparison of values between a particular region and its reference region is made by reading from the lower right-hand corner to the left. An index value approaching zero indicates that the industry structures in the regions being compared have converged, i.e. evolved to become increasingly similar. However, the opposite is true when the index values move towards the value of two at the upper end indicating divergence, i.e. complete dissimilarity.

| TABLE 6 |

The analysis consists of two steps: first, the regions with the lowest index value are identified and examined for the effects of integration on region-pairs. If region-pairs change, then the compositions of industry structures have changed. Second, the extent to which manufacturing structures within the CAP cluster of regions have become more similar is then examined.

The first step in the analysis employs Table 6 to identify the region-pairs with the lowest index value and thus the most similar industry structure. For example, in 1989 there appears to be a very similar industry structure between the two non-adjacent periphery regions of Galicia in the northwest and Andalucia in the south of Spain. The index indicates a value of 0.44, which is the lowest value for both of these regions.

Table 7 lists the pairs of Spanish regions with the lowest index values for the two periods 1989 and 1997. The country is divided into north and south, with Madrid in the middle. When comparing those regions that are most similar in 1989 to the region with the most similar industry structure in 1997, not one pair of regions remained the same. Industry restructuring after integration created new region-pairs.

| TABLE 7 |

In 1989, there were five pairs of adjoining regions (marked with the asterisk *) with varying similarity values in their industry structure. The most dissimilar structure existed between the northern periphery region of Asturias and its adjacent region of Castilla Leon, while a strong similarity appears to exist between a cluster of the three southern periphery regions of Extremadura, Andalucia, and Murcia. The most similar industry structure exists between the core regions of Madrid and Cataluna. The remaining region pairs showing similar industry structures are geographically separated from each other.

For example, the periphery region of Galicia in the north is similar to the periphery region of Andalucia in the south, while the southern adjacent region of Comunidad Valencia is similar to the northern adjacent region of La Rioja. Aragon is similar to Madrid, and not its contiguous core region of Cataluna. Cataluna and its immediate adjacent regions of Comunidad Valencia and Aragon do not have a similar industry structure. In 1989, only one core-adjacent region combination – Pias Vasco and Cantabria – possessed a similar industry structure.

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The analysis reveals that the industry structures between regions have changed as a result of the forces of economic integration. However, since the effect of integration on the industry structures of contiguous regions is under study, it is necessary to examine the changing indexes within the framework of the CAP clusters. Doing so will facilitate a determination of whether industry structures of adjoining regions have converged or diverged.

6.2 The Industry Index within the CAP Framework

The industry index is used to evaluate the extent to which regions in a CAP cluster have converged or diverged. The CAP regions are listed in Table 8a. The region codes are listed in column (1). These codes are used in column (6) to indicate regional connectivity according to the CAP model. The region codes in columns (3) and (4) refer to the foreign bordering regions. The values of the industry index of Table 8 for 1989 are placed in Table 8b and those of 1997 in Table 8c. These two tables reflect the industry structures before and after economic integration in 1992. In Table 8d, the size of the change in the regional index values between 1989 and 1997 are listed.

The CAP model assumes that a core region functions as an attraction or dispersion region for industry. If the core functions as an attraction region, then one would expect a dissimilar industry index value between the core and its adjacent and periphery regions. If, on the other hand, the core region functions as a dispersion region, then one would expect the industry index values to become more similar. The latter would lead to the conclusion that a convergence of industry structures is occurring between contiguous regions, specifically between a core and its adjacent region. The index values in Table 8b and Table 8c facilitate a comparison of industry structures within the framework of the CAP model. A general comparison of the two tables illustrates that economic integration has eliminated all of the industry index values greater than unity. This result suggests a convergence of regional industry structures.

6.2.1 CAP Cluster Pias Vasco

The CAP cluster of Pias Vasco consists of the following core, adjacent, and periphery regions. The core region of Pias Vasco is surrounded by three adjacent regions; Cantabria in the west, Navarra in the south, and La Rioja in the east. The periphery regions belonging to this cluster are Asturias and Galicia in the west.

The industry structure between Pias Vasco and its adjacent regions of La Rioja, and Navarra have converged, as has the index value between Pias Vasco and Castilla Leon. In contrast to this, there is a divergence in industry structure between Pias Vasco and its adjacent region of Cantabria. There is also a significant convergence between Pias Vasco and its periphery region of Asturias. Specifically, the index value changed from 1.09 in 1989 to 0.63 in 1997. With the exception of Cantabria, the regions in the CAP cluster of Pias Vasco demonstrate a convergence in their industry structures. Furthermore, the adjacent regions of Pias Vasco show a stronger convergence with their core region than with the adjoining regions of a different CAP cluster. In this case, there is a marginal divergence of structures.

In this cluster the ex ante border periphery region of Galicia displays a significant convergence of industry structure with its peripheral region of Asturias, as well as with its core region of Pias Vasco between 1989 and 1997 (Galicia – Asturias from 1.03 to 0.49, and Galicia – Pias Vasco from 1.01 to 0.50). There is also some convergence with the adjoining region of Castilla Leon, which belongs to the Madrid cluster. This strong convergence of industry structure in Galicia with the other regions in its cluster can largely be explained by its geographic border position with the Portuguese core region of Norte. In fact, this development is a prime example of the operation of the dispersion effect in a border region, due to trade liberalisation with a foreign core region (Krugman and Venables, 1996).

6.2.2 CAP Cluster Cataluna

The CAP cluster of Cataluna is composed of the following adjacent regions: Aragon to the west and Communidad Valencia to the south. In addition to these adjacent regions, the periphery region of Murcia belongs to this cluster.
The index values reveal that the core region of Cataluna diverged in industry structure from both its adjacent regions. Specifically, it has become more dissimilar from Aragon, increasing from 0.45 in 1989 to 0.69 in 1997, and for Communidad Valencia from 0.61 in 1989 to 0.91 in 1997. In contrast, the industry structure between Aragon and Communidad Valencia remained constant. This consistency is demonstrated by the similarity in index values, changing marginally from 0.65 in 1989 to 0.66 in 1997. However, Cataluna shows a divergence in industry structure with all other contiguous regions. Similarly, the industry structure of Aragon diverged from all its adjoining regions in 1997, with the exception of Castilla La-Mancha where the change from 0.70 in 1989, to 0.49 in 1997 indicates that a convergence occurred between these two regions.

It is of further interest to note, that the periphery region of Murcia displayed a relatively strong convergence with its core region of Cataluna. In fact, the index value changed from 0.85 in 1989, to 0.46 in 1997. Murcia, on the other hand, exhibits a growing dissimilarity with the adjoining regions of Castilla La-Mancha and Andalucia; both belong to the CAP cluster of Madrid. Based on these findings, we can conclude that agglomeration forces dominated between the core region of Cataluna and its adjacent regions. This divergence of industry structures between the core and its adjacent regions from that of 1989 indicates a recomposition of industry structures in these regions. In addition to this, we can conclude that the competition effect is strong between cataluna and its periphery region of Murcia.

6.2.3 CAP Cluster of Madrid

The CAP cluster of Madrid consists of five regions. The two large adjacent regions of Castilla Leon and Castilla La Mancha surround the core region of Madrid. Contiguous to these adjacent regions are the two periphery regions of Andalucia and Extremadura.

A comparison of the index values reveals that the industry structures between Madrid and its two adjacent regions became nearly identical (respectively 0.56 and 0.57). Of the two adjacent regions, Castilla La Mancha experienced the most significant change. On the other hand, there is a strong divergence of industrial structures between Madrid and its two periphery regions of Extremadura and Andalucia. These two periphery regions in the Madrid cluster border on Portugal, and like the border region of Galicia, both could be experiencing industry structure change that is more aligned to that of Portugal. Andalucia, however, does show a strong historical affinity with the periphery region of Murcia. The industry structures converged marginally from 0.49 in 1989, to 0.47 in 1997.

6.3 Conclusions on Industry Structure

This analysis sheds light on the fact that trade liberalisation influenced the (re)location of firms \( n \) and employment \( L \) within the CAP clusters to alter the industry structures between regions. The outcomes for the CAP clusters of Pias Vasco and Madrid reveal a dispersion of industry, which led to a convergence of industrial structures in the respective core and adjacent regions. In contrast, the CAP cluster of Cataluna witnessed a divergence in industrial structure between the core and adjacent regions.

The competition effect is evident in those cases where core and adjacent regions became more similar. It can be concluded that either; firms within industries dispersed to regions that already possessed an initial level of a particular industry (Forslid \emph{et al.}, 1999), new firms entered into existing industries (clustering) because of economic profits (Krugman, 1991b), and/or new industries located in new regions, such as office machinery and computers in the adjacent region of Navarra, and new industries in the Energy sector locating in the core region of Madrid.

In the case of Cataluna, it must be concluded that agglomeration forces dominated industry relocation because of its \emph{ex post} divergent industrial structure versus its adjacent regions (Krugman, 1991b). Given Cataluna’s favourable geographic distance from the EU geographic core, this development in Cataluna could be evidence of regional industry specialisation (Krugman and Venables, 1996).

In 1989, Spain counted five periphery regions of which only one, Andalucia, showed an \emph{ex post} divergence in industry structure with its core region while the remaining regions experienced a convergence. The periphery regions of Andalucia, Extremadura, and Murcia all show an \emph{ex post} divergent production structure from their adjoining regions. Forslid and Wooton, (1999), and Forslid \emph{et al.}, (1999)
have argued that this divergence could be caused by the location of industries seeking comparative advantage, or as Venables (2000) would argue, industries with low demand elasticities, and low transport intensities seeking a high return on capital investments. Only the two northwestern periphery regions of Asturias and Galicia experienced a convergence of industry structures with all of their adjoining regions. These two regions experienced the largest swings from dissimilarity to similarity.

The explanation for the magnitude of these swings is twofold. To begin with, the border periphery region of Galicia enjoyed the complete benefits of trade liberalisation with the Portuguese core region of Norte. The removal of trade barriers between countries encouraged industrial growth in Galicia (Krugman and Venables, 1996). In addition to this, the improvement of road infrastructure, from Galicia along the northern Spanish coast benefited the geographic location of Asturias as a conduit between Galicia and the core region of Pias Vasco. This development is informative, since it reflects the working of trade liberalisation and domestic infrastructure improvements. This case exemplifies the fact that the competition effect dispersed industries to take advantage of the wage differential favouring the periphery regions (Venables, 1994).

Finally, the three CAP clusters verify the historical existence of a divergent multi-agglomerate production structure in Spain where trade liberalisation served as a catalyst for strong convergent industry developments between core and adjacent regions. The multi-agglomerate structure of Spain is evidenced by the duplication of northern industry structures in the southern regions of Extremadura, Commanded Valencia, Andalucia, and Baleares. This implies that industries have relocated, but are not highly localised, and that trade liberalisation did not destabilise the original centres of production (Krugman and Venables, 1996). Trade liberalisation, however, did result in a recomposition of industry structures and industry concentration.

7 Industry Concentration

Trade liberalisation induces a relocation of manufacturing concentration (Krugman and Venables, 1996). To measure the concentration of manufacturing activity the empirical literature uses the location-Gini (Krugman, 1991a; Brülhart and Torstensson, 1996; Midelfart et al., 2000). It has also been suggested that one single concentration measure, such as the location-Gini, does not capture the difference in size between countries (Haaland et al., 1999). The literature points to the need for relative and absolute concentration measurements, such as those developed by Amiti (1997) and Forslid (1999). Relative concentration indicates comparative advantage and specialisation in production, while economic geography agglomeration effects are measured by absolute concentration (Haaland et al., 1999; Forslid, 1999). The relative and absolute industry concentration measures apply to industry at the country level, and not the regional level.

This study examines industry concentration at the regional level and therefore needs a regional industry concentration measurement. In the following section a new industry concentration measure is introduced that singularly measures both absolute and relative concentration by relating regional manufacturing employment per industry to the region’s geographic size.

7.1 A Standardised Relative and Absolute Concentration Measurement

The new concentration measure is an alternative to the relative and absolute concentration measurements of Amiti (1997) and Forslid et al., (1999). Their measurements have two disadvantages; first, both are country and not region specific; and, two, neither measurements consider the dimension of actual regional geographic size. The manufacturing employment location-Gini is also suspect of accuracy since it also fails to consider regional geographic size. It is a relative measurement, like that of Amiti (1997), and uses total regional industry employment as the measure of region size.

21 The region of Galicia on the west coast has four airfields; two in the urban area La Corunna, and two in the urban area Vigo. Both urban areas have Atlantic coast harbours. The core region of Pias Vasco has two airfields.
Haaland et al., (1999) emphasise the necessity of considering country size in the choice of a concentration measure. The authors argue that ‘an industry is relatively concentrated if it differs from the average spread of production between countries [regions]; it has a high degree of absolute concentration if it is unevenly distributed between countries [regions].’

The new measurement is called the ‘manufacturing labour-land concentration ratio’ and takes into consideration the geographic size of a region. The advantage of the labour-land concentration ratio is that it measures the concentration of regional manufacturing employment per industry per square kilometre, thereby eliminating the issue of region size i.e., small versus large regions. An industry can be both absolutely and relatively concentrated, but not in the same region. Regional relative and absolute concentration of an industry is mutually exclusive.

The absolute labour-land concentration measurement is constructed as follows. Let the regional labour-land ratio be defined as follows:

\[ l_{ij} = \frac{E_{ij}}{N_{j}^2} \]

0 = \( l_{ij} = 1 \) \hspace{1cm} (7.1)

where, \( E_{ij} \) is the number of people employed in industry \( i \) in region \( j \), and \( N_{j}^2 \) is the geographic area of region \( j \) measured in square kilometres. We now calculate a standardised labour-land ratio, \( L_{ij} \), for each industry \( i \) in region \( j \) and assume the calculated values represent a standard normal distribution of an industry across the regions. The data is normalised in the following way:

\[ L_{ij} = \frac{l_{ij} - \bar{L}_i}{\sigma_L} \]

\hspace{1cm} (7.2)

where, \( l_{ij} \) is the labour-land ratio in industry \( i \) in region \( j \); \( \bar{L}_i \) is the average labour-land ratio industry \( i \); and \( \sigma_L \) is the standard deviation of the labour-land ratio industry \( i \). The standardised variable \( L_{ij} \) has a mean \( \mu = 0 \), and standard deviation \( \sigma_L = 1 \). For a standardised normal distribution, 99.38% of all observations lie within ±2.5 standard deviations from the mean, and 99.9% lie within ±3 standard deviations from the mean.

For any standardised variable the null hypothesis assumes that the value of the observation is not significantly different from a zero mean i.e. \( H_0: \mu_{L_{ij}} = 0 \). If the null hypothesis cannot be rejected, then the observed value of \( L_{ij} \) is not significantly different from its mean value and suggests that the observations are dispersed around the mean. The region with the highest \( L_{ij} \) value falling within the area of non-rejection will have the highest relative concentration in that industry. Therefore, an industry is relatively concentrated or dispersed between regions if the standard deviation of the manufacturing labour-land concentration ratio has a positive value around the mean and falls within the area of non-rejection.

The alternative hypothesis states, that the observed value is significantly different from the zero mean i.e. \( H_1: \mu_{L_{ij}} \neq 0 \). If the null hypothesis is rejected and the alternative hypothesis is accepted, then the observed value of \( L_{ij} \) falls within the area of rejection, which means that it is significantly different from its mean value with a 0.001 percent chance of falling within the area of non-rejection. The region with the highest \( L_{ij} \) value falling in the area of rejection will have the highest absolute concentration in that industry. An industry is absolutely concentrated if the concentration ratio falls in the critical rejection area.

By way of summary, a region will have a relative concentration in industry \( i \), if \( 0 < L_{ij} < 3s \), and an absolute concentration in industry \( i \), if \( L_{ij} > 3s \). The standardised employment values measure industry concentration as a deviation from the mean industry employment value in a particular region.
7.2 Empirical Outcomes of the $Lij$ Concentration Measurement

In Table 9 below, the industries are grouped into four categories: one, industries that remained concentrated (CC); two, dispersed industries that increased their concentration (DC); three, concentrated industries that became more dispersed (CD); and four, dispersed industries (DD) that remained dispersed but experienced a change in their level of concentration.

The nine industries categorised as (CC), (CLC) and (CMC) have an absolute concentration value $L_{ij} > 3s$. Eight of the nine industries are located in core regions with one in a periphery region. Industries categorised as (DC) have a concentration measure that changed from relative concentration $L_{ij} < 3s$, to absolute concentration, $L_{ij} > 3s$. One of these industries is located in an adjacent region. The industries categorised (CD) have an industry concentration measure $L_{ij}$ that changed form an absolute concentration value $L_{ij} > 3s$, to a relative concentration value, $L_{ij} < 3s$. All three industries are located in core regions. Finally, the industries categorised as (DD), (DLD) and (DMD) remained relatively concentrated, $L_{ij} < 3s$. These industries are equally dispersed over core and adjacent regions.

### TABLE 9

7.2.1 An Analysis of the $Lij$ Concentration Measurement

The standardised concentration ratios are ranked by region and per CAP cluster in Table 10. The regions with the highest absolute and relative concentration values are listed in column (1). The regions with a positive standard deviation are ranked for each industry in columns (2) – (4).

The outcome indicates nine industries increased their concentration in core regions, one in an adjacent region, and one in a periphery region. Three industries in core regions showed a marginal decline in absolute concentration. This leaves nine industries with relative concentrations spread over core and adjacent regions.

7.2.2 Increased Concentration (CC)

Nine industries have $L_{ij}$ values that remained in the critical region post EU 1992. These industries have an absolute labour-land concentration coefficient. Five of the nine industries are located in the CAP cluster Pias Vasco, three in the CAP cluster of Madrid, and one in the CAP cluster of Cataluna. All industries are located in core regions with the exception of quarrying and mining of energy materials located in the periphery region of Asturias.

Three industries experienced a marginal decline (CLC), but maintained their absolute concentration status. The industries rubber and plastics, and fabricated metal products experienced a decline in the core region of Pias Vasco with an increased relative concentration in the remaining two core regions. Absolute concentration also declined in the textile industry in the core region of Cataluna with relative concentration increasing in its adjacent region of Communidad Valencia. The remaining six industries increased their absolute concentration levels in the core regions, reducing the relative concentrations in the other two core regions.

### TABLE 10

7.2.3 Dispersed More Concentrated (DC)

Five industries showed a relative concentration value of $L_{ij} < 3s$ in 1989, but became absolutely concentrated $L_{ij} > 3s$ in 1997. In the Energy sector, increased concentration occurred in three industries in the core region of Madrid (coke refinery and nuclear energy, electricity, gas and steam, and purification and distribution of water). In the Other Manufacturing sector, increased concentration in the wearing apparel industry is evident in the core region of Madrid; the leather and leather products industry relocated from the core region Madrid to the adjacent region of Communidad Valencia. The industries classified as (CC) and (DC) combined, experienced an increased absolute concentration in ten industries of which nine occurred in core regions.

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22 The classification method is conform that of Midelfart et al., (2000).
7.2.4 Concentrated More Dispersed (CD)

The chemicals and man made fibre industry was absolutely concentrated in the core region of Madrid in 1989, but showed a relative concentration in 1997 in the core regions of Madrid with an increase occurring in Cataluna. The motor and trailer industry, with an absolute concentration in Madrid in 1989, experienced an absolute concentration decline in 1997 to one of increased relative concentration in the core agglomerates of Cataluna and Pias Vasco. Finally, a similar change in absolute concentration occurred in the other transport sector in the core region of Pias Vasco with relative concentrations relocating to the core region of Madrid and the adjacent region of Galicia.

7.2.5 Dispersed Less/More Dispersed (DD)

The industries in this category all have a relative labour-land concentration coefficient. This group is comprised of six industries of which two industries experienced more dispersion (DMD), and four industries less dispersion (DLD). In Galicia, the industry quarrying and mining of non-energy materials decreased its relative concentration level, but increased its relative concentration in the adjacent region of Cantabria in the same CAP cluster. The food, beverage and tobacco industry in Madrid experienced a marginal relative concentration decline in its own core region, and an increased relative concentration share in the core regions of Cataluna and in the island-periphery region of Canarias.

The four industries that became less dispersed (DLD) maintained the initial relative concentrations in the same regions, but resulted in a change in relative concentration in non-adjacent core regions. In the industry, electrical machinery and apparatus the relative concentration ratio increased in the core regions of Madrid and Cataluna, but declined in Pias Vasco. The relative concentration ratio of the manufacture of jewellery and musical instruments increased in the core region of Madrid and declined in Pias Vasco and Comunidad Valencia. The relative concentration of the wood products industry increased in the adjacent region Comunidad Valencia and its core region Cataluna, and became relatively less concentrated in Pias Vasco and Madrid. Finally, the non-metallic industry increased its relative concentration in the adjacent region of Comunidad Valencia and Madrid at the expense of the core region Pias Vasco.

In general, only two industries in the group (DC) relocated to different regions as a consequence of their increased absolute concentration between 1989 and 1997. In the Energy sector the industry coke, refinery and nuclear relocated from the periphery region Asturias to the core region of Madrid. In the Other Manufacturing sector, the industry leather and leather products relocated from the core region of Madrid to the adjacent region of Comunidad Valencia in the CAP cluster Cataluna. Industry concentration in all other categories (CC), (CD) and (DD) – twenty-one industries – remained in the regions of their respective initial concentration. Of the total twenty-three industries, seventeen are located in core agglomerates, one in a periphery region Asturias, one in the adjacent region of Galicia, and three in the adjacent region Comunidad Valencia.

What is significant about the new absolute and relative labour-land concentration measurement? First, it relates employment per industry to a square kilometre thereby compensating for a region’s geographic size. Since the new economic geography focuses on industry location, then its concentration must be measured geocentrically. Second, it relates consistently to the centrality theory within the framework of the CAP model. The majority of industries are absolutely or relatively concentrated in core agglomerates. The measurement unequivocally facilitates the necessary proof for regional diversified agglomeration (Krugman and Venables, 1996) and the home market effect (Krugman, 1991b; Davis and Weinstein, 1999). Third, it supports the seamless concentric circle theory by identifying manufacturing dispersion (relative concentration) to adjacent and periphery regions (Von Thünen, 1823), thereby revealing the strength of the competition effect (Krugman, 1991b; Venables, 1994; Baldwin et.al., 2002).

7.3 An Empirical Examination of Industry Characteristics

Midelfart et.al., (2000) have identified industry characteristics in their study of EU industry location at the national level. These industry characteristics are applied to the industries in the regions of Spain and are listed in Table 11. The industry characteristics are categorised as high (H), medium (M) and low (L).

[Table 11]
In Table 12, the industries and their characteristics are presented in their CAP clusters and region types in which their absolute and relative concentration occurs. We are interested in answering the question; “Is there a difference in industry characteristics between the CAP clusters that determines their location?”

7.3.1 The (CC) Industries

The eight (CC) industries are located in two core agglomerates and have increased their concentration at the expense of the adjacent, periphery and core regions. The (CC) industries are located in the core agglomerates of Pias Vasco and Madrid. The difference in industry characteristics between these two agglomerates is that industries located in Madrid have a higher technology requirement, a higher need for intra and inter-industry inputs, and higher skill requirements. Industries in Madrid use a larger share of agricultural inputs, and produce relatively more for home consumption. Industries in Pias Vasco are more capital intensive, use low levels of agricultural inputs, and have a low demand bias indicating strong home market effects (Davis and Weinstein, 1999). The industry quarrying and mining of energy materials is completely concentrated in the periphery region of Asturias suggesting natural regional comparative advantage (Ellison and Weinstein, 1999). The CAP cluster Pias Vasco is in close geographic proximity to the core regions of Portugal in the west and borders on France to the north. The regions in this cluster could possibly be developing an export industry.

7.3.2 The (CLC) Industries

The three (CLC) industries located in core agglomerates have an absolute concentration that has declined but remains absolute. There are no (CLC) industries in Madrid. Two of these industries are located in the core region of Pias Vasco, and one in the core region of Cataluna. In Pias Vasco the industries fabricated metal products, and rubber and plastics have the opposite characteristics except for inter-industry linkages, industry growth, and use of agricultural inputs. The fabricated metal products industry, like other (CC) industries in Pias Vasco, has a medium level of internal returns to scale, medium intra- and inter-industry linkages, and requires medium capital intensity. It is has a low final demand bias indicating it is an export industry.

The rubber and plastics industry is a supplier industry with low level of internal returns to scale, a high level of inter-industry linkages, a medium skilled labour requirement, and a medium final demand bias. The industry’s relative concentration levels have increased in the core agglomerates of Madrid and Cataluna. The industry’s medium final demand bias, medium levels of skilled labour needs, and high levels of inter-industry needs, suggests that industry relocation is fuelled by the need for domestic expenditure, skilled labour and technology availability, and inter-industry linkages available in the larger two core agglomerates (Krugman and Venables, 1996).

The third (CLC) industry is the textile industry with a declining, but stable, absolute concentration in the core agglomerate Cataluna. The industry has experienced an increase in relative concentration in its adjacent region of Communidad Valencia. The industry is characterised by low internal returns to scale, high intra-industry linkages, medium capital intensity, a high use of agricultural inputs, and a high final demand bias. The increased relative concentration in the adjacent region suggests a possible need for an input-output structure with similar industries in the core; this, combined with low internal returns to scale, suggests relatively high product transport intensity (Venables and Limao, 2002). Also, the industry produces primarily for domestic consumption and therefore needs to locate in the largest domestic home market, which is the core agglomerate of Cataluna.

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23 See Table 10
7.3.4 The (DC) Industries

The (DC) industries are those that have changed from relative to absolute concentration. Two of the (DC) industries are located in core agglomerate Madrid and one in the core agglomerate Cataluna. In Madrid, the coke, refinery and nuclear energy industry has become absolutely concentrated out of need for high internal returns to scale, medium inter-industry linkages, high capital intensity requirements, the need for skilled labour, and high final demand bias. It has low levels of agricultural inputs. The industry has relocated from the periphery region Asturias that is left with a small relative concentration.

The wearing apparel industry has found absolute concentration in the core region of Madrid. The industry has low levels of internal returns to scale, is highly dependent on intra-industry linkages, has a high final demand bias, and possibly a high demand elasticity. The industry is highly dependent on agricultural inputs that bear transportation costs, making the industry transport intensive. It therefore needs to be located in its largest domestic home markets. The industry also shows dispersion to the core agglomerate of Cataluna, which has the highest relative concentration coefficient. The industry has relocated primarily from the adjacent region of Communidad Valencia.

The leather and leather products industry has an absolute concentration in the adjacent region of Communidad Valencia. The industry has relocated almost entirely from the core agglomerates of Madrid and Cataluna. This industry is also characterised by low internal returns to scale, high intra-industry linkages, medium capital intensity, a high use of agricultural inputs, and produces primarily for the domestic market. The industry is highly dependent on agricultural inputs, making its commodities relatively transport intensive.

7.3.5 The (CD) Industries

There are three (CD) industries that have lost their absolute concentration, have become more dispersed, and now have relative concentration. The first (CD) industry is the other transport industry located in the core agglomerate of Pias Vasco. The industry has dispersed primarily to the core agglomerate Madrid. The other transport industry in Pias Vasco is characterised by high internal returns to scale, low intra-industry linkages, but high inter-industry linkages. It requires medium levels of technology, capital intensity, and skilled labour. It requires low levels of agricultural inputs, shows low industry growth, and has a low final demand bias.

The other transport industry is a supplier industry. Relocation to Madrid could be driven by its need for high internal economies of scale, and high inter-industry linkages. Since this is an export industry, these relocation developments suggest the need to minimise the high transport intensity costs of importing intermediate products from the core region of Madrid. By relocating to Madrid, it reaps pecuniary agglomeration benefits, which allows it to remain competitive in foreign markets. The developments in this industry embody the forces of the new economic geography theory of home market effect, transport intensity of commodities, and satisfying idiosyncratic demand (Krugman, 1991b; Krugman and Venables, 1996; Davis and Weinstein, 1999; Venables and Limao, 2002).

The remaining two industries in the (CD) group are located in the core agglomerate of Madrid. The industries chemicals and man made fibres, and motors and trailers have both experienced relocation to the core agglomerate Cataluna, whose relative concentration coefficients have increased for both industries. The industry branch motors and trailers has become relatively more dispersed than the chemical branch since it has also relocated to the core agglomerate of Pias Vasco, whose relative concentration coefficient is approximately the same as that of Cataluna. The two industries are similar in their need for high internal returns to scale, medium levels of technology, and high intra-industry linkages.

The chemical industry is a supplier industry and requires low inter-industry linkage, but high capital intensity and high levels of skilled labour. The industry has experienced medium growth, and has a medium final demand bias. Since the chemical industry is producing for domestic and foreign consumption it will locate in large markets such as Cataluna with initial high industry shares, to reap the pecuniary agglomerate advantages from high intra-industry linkages and high internal economies of scale (Forslid et. al., 1999). The industry can supply the southern and northern European market from these two core agglomerates (Davis and Weinstein, 1999).
The motors and trailers industry has characteristics similar to the chemical industry. It, however, has a high final demand bias suggesting production primarily for the domestic market. To minimise the transport intensity costs of its high dependence on intra-industry inputs, and to realise high levels of internal returns to scale, this industry is dispersing and relocating to core agglomerates with initial ‘high’ industry shares and to the adjacent region of Navarra with initial ‘low’ industry share (Krugman and Venable, 1996).

7.3.6 The (DD) Industries

The categories (DMD) and (DLD) contain industries that are relatively concentrated and experience an increase or decrease in this position. In the CAP cluster of Pias Vasco the industry quarrying and mining of non-energy materials has a decline in relative concentration (DMD) in the ex post adjacent region Galicia, and relocated to the adjacent region of Cantabria with an equal relative concentration. Both Galicia and Cantabria are adjacent regions. The industry is characterised by high internal returns to scale, intra-industry linkages, and capital intensity. It has low inter-industry linkage, and medium levels of technology, skilled labour, and a medium final demand bias, producing for domestic consumption and export. The industry has medium growth levels.

In the CAP cluster of Cataluna, the industries wood products and non-metallic minerals have relative concentration levels and are both becoming less dispersed (DLD). Both industries are located in the adjacent region of Communidad Valencia. The industry characteristics are similar except for internal returns to scale, skilled labour requirements, final demand bias, and use of agricultural inputs. The non-metallic industry has a low final demand bias and a high need for agricultural inputs. It is a transport intensive industry competing in foreign export markets. The wood products industry has a high use of agricultural inputs and a medium demand bias requiring location close to the home market.

7.3.7 Conclusion on Relative and Absolute Concentration Analysis

It is evident that the industrial structure of core regions consists of a mix of industries that show both absolute and relative concentration. For example, the core agglomerate of Pias Vasco has five industries with absolute concentration, and one with relative concentration. Madrid has seven industries that are absolutely concentrated and five industries that are relatively concentrated. The core agglomerate of Cataluna has one absolutely concentrated industry. Adjacent and periphery regions within the CAP clusters also show absolute and relative concentration in five industries.

In general, increased concentration (CC) in one core region is accompanied by declining relative concentration in the remaining core regions. Industries in core regions with a marginal decline in absolute concentration (CLC) increase their relative concentration in other core regions. Dispersed industries with a relative concentration that have become absolutely concentrated (DC) have relocated primarily to the core agglomerate of Madrid, with the exception of one industry that relocated to an adjacent region. Industries that were absolutely concentrated, but became more dispersed (CD) increased their industry relative concentration ratio in another core agglomerate or adjacent region. Dispersed industries that became less dispersed (DLD) increased their relative concentration at the expense of other core regions. The two (DMD) industries are located in two separate CAP clusters. In the CAP cluster Pias Vasco relative concentration ratios became identical in two adjacent regions at the expense of core regions. In the CAP cluster Madrid, dispersion occurred from one core to another core region.

The industry analysis in the stylised facts revealed that new firms in similar industrial sectors locate in both core and adjacent regions of all three CAP clusters. The analysis also revealed that new firms in different industrial sectors cluster in common regions, irrespective of region type, i.e. core and adjacent. The industry characteristics analysis reveals fifteen industries, located in core and adjacent regions, that require medium to high intra-industry linkages, and thirteen industries, located in similar region types, requiring medium to high inter-industry linkages. This evidence supports the concentric circle theory that input-output structures – forward and backward linkages – exist between core agglomerates and their adjacent regions (Paelinck and Nijkamp, 1975; Krugman and Venables, 1996; Midelfart et.al.,2000). The CAP clusters in Spain have developed economic districts (Lösch, 1954; Krugman, 1991a).
Furthermore, the outcome of the industry index analysis revealed greater similarity in production structures between the core agglomerates and their adjacent regions. The existence of a multi-agglomerate production structure has been revealed through the analysis of changes in relative and absolute industry concentration. This evidence supports the theory of diversified agglomeration in the theoretical literature (Krugman and Venables, 1990, 1995, and 1996; Venables, 1994; Ludema and Wooton, 1997; Forslid and Wooton, 1999; Venables and Limao, 2002). Trade liberalisation has not weakened nor destabilised the original core agglomerates. It has, however, changed their industrial composition (Krugman and Venables, 1996).

7.4 CAP Cluster Characteristics

It appears that industry and commodity characteristics are correlated with CAP cluster characteristics. The concentration categories \((CC)\), \((CLC)\) and \((DC)\) comprise twelve industries distributed over the three CAP clusters. Of these, five are located in the cluster Pias Vasco, five in the cluster of Madrid, and two in the cluster Cataluna. On average, the industries in Pias Vasco have a low demand elasticity indicating home market economic geography effects since they produce primarily for the export market (Davis and Weinstein, 1999).

The CAP cluster Pias Vasco appears to have a number of characteristics\(^{24}\) that attract the export industry. First, it has a favourable geographic locational advantage for industries exporting to Portugal, France, and the EU geographic core. Second, it has a modern road and rail infrastructure providing transport routes to Portugal and France. Third, the city of La Corunna in the adjacent region of Galicia has an Atlantic Ocean seaport and two of the six airfields in the CAP cluster Pias Vasco. Since, industries are increasing their concentration in the core agglomerate, it can be assumed that Pias Vasco has an abundance of skilled labour and educational programs to ensure a continued supply of human capital.

The CAP cluster Madrid contains five industries with absolute concentration. On average, these industries have a medium to high need for internal returns to scale, \textit{intra}-industry linkages, and skilled labour. They are characterised by a medium to high final demand bias indicating the need for high demand in home markets. The industries are also characterised by medium to high needs for agricultural inputs. The \((CD)\) and \((DLD)\) industries in Madrid are characterised by a medium to high final demand bias and need for agricultural inputs. The core agglomerate of Madrid has the highest number of industries with absolute and relative concentration.

The CAP cluster Madrid is characterised by its favourable central geographic location equidistant from the core agglomerates Pias Vasco and Cataluna, respectively 624 km and 617 km. It has a modern infrastructure. The region of Madrid consists of 15 urban areas of which six have a total population greater than 100,000 people. It has an urban population of 89.3%, compared to 69.6% in Pias Vasco and 68.9% in Cataluna. The region has a number of universities and vocational institutions providing technological knowledge and a skilled labour force. Two adjacent regions Castilla La Mancha and Castilla Leon whose land use is respectively 63% and 59% agricultural surround the agglomerate Madrid.\(^{25}\) This geographic characteristic makes manufacturing location in Madrid interesting for industries whose commodities are characterised by transport intensive agricultural inputs and yet wish to compete in foreign export markets, such as the industry paper and paper products, wearing and apparel, and the food, beverage and tobacco industries.

The common characteristic of the \((DC)\) industries is the high final demand bias for their commodities and high needs for agricultural inputs, causing their relocation to the high expenditure agglomerates of Madrid and Cataluna. The same is true for one of the \((DLD)\) industries in this CAP cluster. The industry \((DLD)\) non-metallic minerals is an export oriented industry.

The CAP cluster Cataluna is characterised by 35 urban areas of which eight have a population exceeding 100,000 people with a population density in Barcelona 615 people per square kilometre\(^{26}\). Its

\(^{24}\) The source for this information is Eurostat (1993), \textit{Portrait of the Regions}, Volumes. 1-4, Luxembourg.


adjacent region of Comunidad Valencia also has 35 urban areas of which four have a population greater than 100,000 people. The urban population density of Comunidad Valencia is 56.6%. Average land use in Cataluna and Comunidad Valencia is about 43% agriculture and 41% wooded. The CAP cluster Cataluna has three Mediterranean harbours, one in Cataluna in the city Barcelona, and two in Comunidad Valencia in the city Alicante. It has an equal number of airports, one in Barcelona, and two in Alicante. The CAP cluster is characterised by a modern road and rail infrastructure along the northern Mediterranean coast for easy market access to southeastern France, northern Italy, and the EU geographic core. The cluster has Universities and vocational institutions providing technological knowledge and a skilled labour market.

8. Conclusions

This paper has partially examined the endogenous economic mechanisms that comprise the ‘black box’ of the new economic geography model within the CAP framework. The initial outcomes suggest the CAP model to be a functional vehicle for analysing inter-regional and inter-sectoral firm (\(n\)) and labour (\(L\)) movements in a seamless geographic world. The effect of trade liberalisation on wages, production costs, and investment is a topic for subsequent research.

The outcomes support the premise of the concentric circle theory that industry location radiates outward in multi-directions from a central location. The CAP model, through the concept of CAP clusters, facilitates the industry index analysis in exposing the convergence or divergence of industry structures in the first concentric circle around the core. When applied to the second concentric circle, the model reveals that even industries in these regions tend to develop industry structures similar to their nearest core region. In the case of the CAP cluster Pias Vasco the distance of production location from the core becomes less relevant if the commodity has a low final demand bias.

The concentric circle theory approach to the analysis of industry location provides the distinct advantage of identifying one or more core regions within a country that act as an economic development axes, attracting and dispersing economic activity to its surrounding regions. The CAP model allows for the measurement of this spatial activity. The outcome has revealed a major theoretical premise by Krugman and Venables (1996) that supplier and final goods producers seek to cluster for pecuniary agglomerate advantage. The regional CAP model identified this behaviour by examining the sectoral distribution of industries within the CAP clusters. It found five distinct instances where supplier and final goods producers clustered in a common region or the combination of core and adjacent regions. Contrary to the results reported by Midelfart et al., (2000), a region’s initial ‘low’ or ‘high’ share in an industry appears to be important for industry clustering. Core regions with high initial shares attract new firms into the industry dispersing other firms in need of forward and/or backward linkages to the adjacent regions.

The new manufacturing labour-land concentration ratio verifies the initial signals from the industry index analysis that Spain is characterised by a multi-agglomerate production structure. This study does not make the claim that the relative concentration ratio measures Heckscher-Ohlin comparative advantage and specialisation in production, or that the absolute concentration ratio measures Krugman’s (1991b) economic geography and economies of scale. However, first indications do suggest that on average industries experiencing absolute concentration (\(CC\), in the core agglomerates are characterised by low to medium final demand bias indicating strong economic geography home market effects, as found by Davis and Weinstein (1999). Industries with relative concentration ratios are located in core and adjacent regions and are characterised as industries in the dispersed – more/less – dispersed categories, (DLD) and (DMD). On average, these industries show a medium to high final demand bias indicating the need for proximity to high domestic expenditures. These industries show greater dispersion across the CAP clusters suggesting regional specialisation in production for domestic consumption. Multiple production locations would lead one to deduce that these industries have commodities with high demand elasticities and high transport intensities dependent on intra and inter-industry inputs.

Finally, the CAP model proves the multi-agglomerate production structure in Spain. It is not unreasonable to conclude that this polycentric production structure is the result of the geographic location and characteristics of the three agglomerates. The CAP cluster Pias Vasco in the northwest has a
favourable geographic export location to France, Portugal, and the rest of the world via the Atlantic Ocean harbours. The CAP cluster Madrid is centrally located, equidistant from Pias Vasco and Cataluna. A high percentage of its land use, and that of its adjacent regions, is agricultural production, whose output serves as inputs (medium and high) for six of the twelve industries concentrated in the agglomerate. The CAP cluster Cataluna is the largest home market in Spain. Its prime characteristic is its share of domestic expenditure for firms with high final demand bias and transport intensive commodities. Its industry structure is favourable to all industries since it provides high levels of forward and backward linkages, *ergo*, pecuniary agglomerate advantages, which provides its comparative advantage. Like Pias Vasco, the cluster Cataluna has a rail, road, air, and harbour infrastructure to the outside world.
References


DATA SOURCES


### TABLE A.1
MANUFACTURING INDUSTRY DATA

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<td>Mining and quarrying of energy producing materials</td>
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### TABLE A.2B
REGIONAL CLASSIFICATION LEGEND

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<td>Region adjacent to a core with two urban area with a population density between 100– 500 / km²</td>
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MAP A.1
ADMINISTRATIVE REGIONS OF SPAIN, PORTUGAL, AND FRANCE


TABLE A.2A
REGIONAL CLASSIFICATION OF THE SPANISH REGIONS

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MAP A.2
CLASSIFIED SPANISH REGIONS
**Table A.3**

**EMPLOYMENT CHANGE AND REGIONAL INDUSTRY SHARE**

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<tr>
<td>(23) Mncfrg, Jewelry, Musical</td>
<td>D N</td>
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<td>3977</td>
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<td>222</td>
<td>657</td>
<td>3804</td>
<td>1420</td>
<td>21195</td>
<td>8112</td>
<td>912</td>
<td>2924</td>
<td>2618</td>
<td>41733</td>
<td>1559</td>
<td>5076</td>
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**NEW JOBS**

|     | 4377 | 21003 | 6320 | 1573 | 10678 | 10076 | 6887 | 8926 | 5777 | 16177 | 2454 | 22924 | 10740 | 108899 | 75795 | 11088 | 6989 |

**Source:** Author's own research. Data from Eurostat.

L = low initial levels  
H = high initial levels  
N = new establishment  
C = comparative advantage

Tentative Version
### TABLE 6
SIMILARITY / DIFFERENCE INDEX

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<table>
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<td>Andal. Balrs</td>
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<td>Catal.</td>
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<td>C.Mancha</td>
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<tr>
<td>Balrs</td>
<td>0.66</td>
<td>0.70</td>
</tr>
<tr>
<td>Andal. Murc Can.</td>
<td>0.66</td>
<td>0.70</td>
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</tbody>
</table>

* Indicates the region to which the others are compared.

**Source:** Authors own research.
Tentative Version

Diagram 1
Relationship Between Concentric Circles and Regions

Source: Author’s own construct.

Table 1
Regional Classification of the Spanish Regions

<table>
<thead>
<tr>
<th>CAP Cluster</th>
<th>Regions Type</th>
<th>CAP Cluster</th>
<th>Regions Type</th>
<th>CAP Cluster</th>
<th>Regions Type</th>
</tr>
</thead>
<tbody>
<tr>
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<td>A1:2</td>
<td>Castilla Leon</td>
<td>A2:1</td>
<td>Aragon</td>
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<td></td>
<td>Asturias</td>
<td>P1:1</td>
<td>Madrid</td>
<td>C</td>
<td>Cataluna</td>
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<tr>
<td></td>
<td>Cantabria</td>
<td>A1:1</td>
<td>Castilla La Mancha</td>
<td>A3:5</td>
<td>Comunidad Valencia</td>
</tr>
<tr>
<td></td>
<td>Pias Vasco</td>
<td>C4:1</td>
<td>Extremadura</td>
<td>P3:2</td>
<td>Murcia</td>
</tr>
<tr>
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<td>Navarra</td>
<td>A2:1</td>
<td>Andalucia</td>
<td>P1:3</td>
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</tr>
<tr>
<td></td>
<td>La Rioja</td>
<td>A2:1</td>
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Note: The legend for region types and a map of Spain can be found in the Appendix.

Table 2
Trade Liberalisation Effects on Firm Exit and Entry

<table>
<thead>
<tr>
<th>Industry Sector</th>
<th>Exit 1</th>
<th>Entry 1</th>
<th>Exit 2</th>
<th>Entry 2</th>
<th>Exit 3</th>
<th>Entry 3</th>
</tr>
</thead>
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<tr>
<td>Energy</td>
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<td>-5,287</td>
<td>22</td>
<td>-2,536</td>
<td>1,286</td>
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<td>Extraction &amp; Processing</td>
<td>-260</td>
<td>592</td>
<td>-786</td>
<td>1,939</td>
<td>-224</td>
<td>2,909</td>
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<td>Engineering</td>
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<td>1,823</td>
<td>-2,066</td>
<td>3,191</td>
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<td>5,966</td>
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<td>Other Manufacturing</td>
<td>-6,980</td>
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<td>-13,638</td>
<td>5,685</td>
<td>-10,197</td>
<td>12,349</td>
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<td>-14,437</td>
<td>3,766</td>
<td>-21,777</td>
<td>10,837</td>
<td>-13,447</td>
<td>22,510</td>
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</table>

Source: Author’s own calculations.

Table 3
The Regional Distribution of New Firms Within the CAP Clusters

<table>
<thead>
<tr>
<th>Industry Sector</th>
<th>CAP 1</th>
<th>CAP 2</th>
<th>CAP 3</th>
<th>IPR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>83.3</td>
<td>16.7</td>
<td>9.1</td>
<td>18.2</td>
</tr>
<tr>
<td>Extraction &amp; Processing</td>
<td>62.8</td>
<td>13.3</td>
<td>36.1</td>
<td>15.9</td>
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<tr>
<td>Engineering</td>
<td>63.0†</td>
<td>25.3†</td>
<td>11.7</td>
<td>62.7</td>
</tr>
<tr>
<td>Other Manufacturing</td>
<td>22.5</td>
<td>64.1†</td>
<td>13.4</td>
<td>67.9</td>
</tr>
</tbody>
</table>

Note: CAP 1 = Pias Vasco; CAP 2 = Madrid; CAP 3 = Cataluna; Can = Canarias; and Bal = Baleares; † = initial ‘low’ level
* = initial ‘high’ level. Source: Author’s own calculations.
### Table 4: Relocation of Manufacturing Employment

<table>
<thead>
<tr>
<th>CAP 1</th>
<th>CAP 2</th>
<th>CAP 3</th>
<th>IPR</th>
<th>TOTAL</th>
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<tbody>
<tr>
<td>Loss</td>
<td>New</td>
<td>Loss</td>
<td>New</td>
<td>Loss</td>
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<td>Energy</td>
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<td>406</td>
<td>-14,357</td>
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<tr>
<td>Extraction and Proces.</td>
<td>-8,645</td>
<td>6,673</td>
<td>-10,618</td>
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<tr>
<td>Engineering</td>
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<td>-22,380</td>
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<td>Other Manufacturing</td>
<td>-42,616</td>
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### Table 5: Regional Distribution of New Employment Positions

<table>
<thead>
<tr>
<th>Energy</th>
<th>Extraction and Processing</th>
<th>Engineering</th>
<th>Other Manufacturing</th>
<th>Engineering + O.Man</th>
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<tr>
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<td>CAP 3</td>
<td>IPR</td>
<td>Can Bal.</td>
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<td>C</td>
<td>A</td>
<td>P</td>
<td>C</td>
<td>A</td>
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<tr>
<td>Energy</td>
<td>24.1</td>
<td>0.9</td>
<td>15.7</td>
<td>5.9</td>
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<tr>
<td>Extraction and Processing</td>
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<td>11.7</td>
<td>11.4</td>
<td>11.8</td>
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<tr>
<td>Engineering</td>
<td>30.2</td>
<td>61.3</td>
<td>24.1</td>
<td>50.4</td>
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<td>Other Manufacturing</td>
<td>37.8</td>
<td>26.1</td>
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<td>31.9</td>
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### Table 7: Industry Structure Similarity

<table>
<thead>
<tr>
<th>Reference Region</th>
<th>1989 Index</th>
<th>1997 Index</th>
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<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>Galicia (P, N)</td>
<td>Andalucia</td>
<td>0.44</td>
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<tr>
<td>Asturias (P, N)</td>
<td>Castilla Leon*</td>
<td>0.96</td>
</tr>
<tr>
<td>Cantabria (N)</td>
<td>Navarra</td>
<td>0.41</td>
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<tr>
<td>Pias Vasco (C, N)</td>
<td>Castabria*</td>
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<td>Navarra (A, N)</td>
<td>Cantabria</td>
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<td>La Rioja (A, N)</td>
<td>Comunidad Valencia</td>
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<td>Aragon (A, N)</td>
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<td>Madrid (C, M)</td>
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<td>Castilla Leon (A, N)</td>
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<td>Castilla La Mancha (A, S)</td>
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<td>Comunidad Valencia (A, S)</td>
<td>La Rioja</td>
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<tr>
<td>Baleares (IP, S)</td>
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<tr>
<td>Andalucia (P, S)</td>
<td>Murcia*</td>
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<tr>
<td>Murcia (P, S)</td>
<td>Andalucia</td>
<td>0.36</td>
</tr>
<tr>
<td>Canarias (IP, S)</td>
<td>Murcia*</td>
<td>0.53</td>
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</table>

**Legend:** C = core; A = adjacent; P = periphery; N = North; S = South; M = Middle; and * = adjoining

**Source:** Authors own calculations.
### Table 9: Changes in Regional Industry Concentration: \( L_{ij} \)

<table>
<thead>
<tr>
<th>Increased Concentration (CC)</th>
<th>(RT)</th>
<th>Dispersed More Concentrated (DC)</th>
<th>(RT)</th>
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<td>Quarrying &amp; Mining Energy Materials</td>
<td>P</td>
<td>Electricity, Gas &amp; Steam</td>
<td>C</td>
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<td>Rubber &amp; Plastics (CLC)</td>
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<td>Purification &amp; Distribution of Water</td>
<td>C</td>
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<tr>
<td>Basic Metal products</td>
<td>C</td>
<td>Coke, Refinery &amp; Nuclear</td>
<td>C</td>
</tr>
<tr>
<td>Fabricated Metal products (CLC)</td>
<td>C</td>
<td>Wearing Apparel</td>
<td>C</td>
</tr>
<tr>
<td>Machinery and Equipment</td>
<td>C</td>
<td>Leather &amp; Leather Products</td>
<td>A</td>
</tr>
<tr>
<td>Office Machinery &amp; Computers</td>
<td>C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medical Precision Instruments</td>
<td>C</td>
<td></td>
<td></td>
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<td>Textiles (CLC)</td>
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<td>Paper &amp; Paper Products</td>
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<td>Concentrated More Dispersed (CD)</td>
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<td>Quarrying &amp; Mining Non-Energy (DMD)</td>
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<td>Motors &amp; Trailers</td>
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<td>Non-Metallic Minerals (DLD)</td>
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<td>Other Transport</td>
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<td>Food, Beverages &amp; Tobacco (DMD)</td>
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<td>Wood Products (DLD)</td>
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<td></td>
<td></td>
<td>Manufacture of Jewellery &amp; Musical (DLD)</td>
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</table>

Source: Author’s own research. RT = region type; C = Core, A = Adjacent, P = Periphery, and IP = Island Periphery.

### Table 10: Changes in Industry Relative and Absolute Concentration Per CAP Cluster 1997 & 1989

<table>
<thead>
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<th>CAP Cluster Pias Vasco</th>
<th>Year</th>
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<th>Region</th>
<th>( L_{ij} )</th>
<th>Region</th>
<th>( L_{ij} )</th>
<th>Region</th>
<th>( L_{ij} )</th>
<th>Region</th>
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<td>Pias Vasco</td>
<td>1989</td>
<td>3.4</td>
<td>Pias Vasco</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Machinery and equipment</td>
<td>1997</td>
<td>3.4</td>
<td>Pias Vasco</td>
<td>1989</td>
<td>3.4</td>
<td>Pias Vasco</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Fabricated metal products</td>
<td>1997</td>
<td>3.4</td>
<td>Pias Vasco</td>
<td>1989</td>
<td>3.6</td>
<td>Pias Vasco</td>
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<tr>
<td>Rubber and Plastics</td>
<td>1997</td>
<td>3.1</td>
<td>Pias Vasco</td>
<td>1989</td>
<td>3.4</td>
<td>Pias Vasco</td>
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<td>Other transport</td>
<td>1997</td>
<td>2.8</td>
<td>Pias Vasco</td>
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<td>3.2</td>
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<tr>
<td>Office machinery and computers</td>
<td>1997</td>
<td>3.9</td>
<td>Madrid</td>
<td>1989</td>
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<td>Madrid</td>
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<tr>
<td>Medical precision instruments</td>
<td>1997</td>
<td>3.6</td>
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<td>1989</td>
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<td>Madrid</td>
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<tr>
<td>Paper and paper products</td>
<td>1997</td>
<td>3.8</td>
<td>Madrid</td>
<td>1989</td>
<td>3.6</td>
<td>Madrid</td>
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CAP Cluster Madrid Office machinery and computers

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Source: Author’s own research. RT = region type; C = Core, A = Adjacent, P = Periphery, and IP = Island Periphery.
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Source: Midelfart et al. (2000), Box 2.2, p.13

### Table 12: Industry Characteristics

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Source: Industry characteristics taken from Table 3.4 in Midelfart et al. (2000). † = no industry characteristics available
### TABLE 8a

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### TABLE 8b

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Source: Authors own research

### TABLE 8d
CHANGES IN INDUSTRIAL REGIONAL STRUCTURES 1989 - 1997

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