A REGIONAL CORE, ADJACENT, PERIPHERY MODEL FOR NATIONAL ECONOMIC GEOGRAPHY ANALYSIS

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Abstract

This paper presents a national regional model of economic geography. The model defines and classifies a country's regions into three types according to population density criteria. The regions within a country are typified as; core, adjacent, and periphery. The benefit of this classification is twofold. One, it provides a simple three-region economic geography model consisting of a core, adjacent and a periphery region that easily expands into a multi-region model. Two, it reveals whether a country's economic geography consists of a multi-agglomerate production structure. The model is significant because it permits an examination of the endogenous forces of economic geography. Furthermore, it allows for the identification of homogenous region types between countries in a common market such as the EU. Finally, the model provides an alternative empirical framework to the conventional core periphery model of economic geography analysis.

Keywords: economic geography, regional nomenclature, concentric circle theory, agglomerate, EU geographic core periphery.

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

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1 Introduction

This paper presents a national regional economic geography model that facilitates the empirical analysis of industry concentration. The model draws on the theoretical contributions of regional economists to economic geography (von Thünen, 1842; Weber, 1909; Lösch, 1954; Boudeville, 1963; Pottier, 1963; Paelinck and Nijkamp, 1975), and presents a national regional framework for the analysis of industry location and relocation between the regions *within* a country.

The current empirical economic geography literature (Brülhart and Torstensson, 1996; Davis and Weinstein, 1998; Forslid *et.al.,*1999; Midelfart *et.al.,* 2000) that examines changes in industrial concentration follows the generally accepted theoretical core periphery theme (Krugman, 1991b; Krugman and Venables, 1995; Fujita, Krugman and Venables, 1999) that the core is characterised by industrial countries, such as the countries belonging to the EU geographic core.[1] The periphery is characterised by countries with a relatively less developed industrial structure than the core, and a relatively larger emphasis on agricultural production, such as those countries belonging to the EU geographic periphery.

In departing from the conventionally accepted country analysis, Davis and Weinstein (1999) examine the home market effect of the new economic geography at the regional prefecture level in Japan. The authors, however, do not develop a formal national regional economic geography model within which to analyse industry concentration and changes therein. This paper aims to fill that gap in the empirical literature by presenting a national multi-regional model.

The objective of this paper is fivefold. First, to revive and embrace the regional nomenclature as developed by regional economists. Second, to define the term 'an agglomerate' as the central place of production concentration. Third, to develop a national multi-region model based on von Thünen's concentric circle theory. Fourth, to classify the region types in each of the EU member countries. Fifth, to introduce stylised economic geography facts about the structure of the CAP regions. The paper will not examine industry concentration or the endogenous forces of economic geography. The sole

[1] Countries belonging to the EU geographic core are considered to be: the UK, Belgium, Luxembourg, the Netherlands, Germany, France, and Italy. Countries belonging to the EU geographic periphery are Ireland, Denmark, Sweden, Finland, Spain, Portugal, and Greece.

objective is to present a model at the national regional level within which these forces can subsequently be examined.

This national regional model is a new contribution to the economic geography literature and is significant for a number of reasons. First, since the model is national in scope, it is consistent with the assumption of Krugman's (1991b) core periphery model of imperfect competition and perfect interregional mobility of manufacturing labour within a country (as in Davis and Weinstein, 1999). Second, the model serves empirical research objectives and allows for the application of Fujita, Krugman, and Venables' (1999) theoretical multi-region models of industrial development and manufacturing concentration. Third, it classifies regions within and across countries according to uniform criteria. This classification facilitates subsequent comparisons of economic development and manufacturing structures in homogenous and heterogeneous domestic and international regions.

The paper is organised into the following sections. Section 2 develops a common nomenclature for national regions. In Section 3, the origin of the term 'an agglomerate' is discussed and defined. In Section 4, von Thünen's (1842) concentric circle theory is used to develop a national regional model. In Section 5, the national regions are classified by region type and a number of stylised facts are examined by applying the model to the individual member countries of the European Union. In Sections 6, the core regions that define the EU geographic core are identified. Section 7, identifies the EU independent core-regions. In Section 8, a simple statistical analysis is undertaken to examine whether the CAP structure supports the theoretical forces of the 'new' economic geography theory. The conclusions are presented in Section 9.

2 A Nomenclature for National Regions

In past studies by regional economists, countries are divided into national regions (Paelinck and Nijkamp, 1975). In these studies, regions are geographical areas of unequal size whose boundaries are determined either by their geography or by an administrative area. A region has a vector of measurable and quantifiable characteristics such as natural resource endowments, population demographics, industrial structures, infrastructure, institutions, villages, towns, cities, and

metropolises. Not all national regions are equally endowed with elements in this vector of characteristics. The disparate attributes of the regions reflect the evolution of economic activity due to geography, location, historical economic development, and entrepreneurial behaviour.

National regions can be ranked on the basis of the quantitative values of their demographic and economic variables, thereby providing a portrait of the range of economic (manufacturing) activity as it is dispersed (or concentrated) over the national regions.

Regional economists have traditionally distinguished between two classes of regions, *administrative* and *programming* (Paelinck and Nijkamp, 1975). The demographic characteristics in an administrative region allows it to be classified into one of four categories – *polarised, contiguous, periphery*, and *natural.* A programming region is a combination of one or more administrative regions.

2.1 Administrative Region

A country is politically defined by a border, as are its provinces, regions, and counties. An *administrative region* is an area defined by an administrative boundary. Political boundaries are national borders, while administrative boundaries are regional borders separating regions within a nation. An administrative region defines an individually circumscribed geographic area with a demographic and economic structure. However, an administrative region's economic structure may not always be confined within its administrative boundaries. Intersectoral linkages may create input-output relationships causing an economic structure to extend beyond a single administrative boundary into an adjoining administrative region, thus creating interregional economic linkages.

Administrative regions are significant since they serve as a starting point for government intervention and planning. Economic policy aimed at a specific administrative region may have no effect on that region if the intersectoral and interregional linkages are not clearly identified (Paelinck and Nijkamp, 1975). In the EU, regional policy measures through the European Reconstruction and Development Fund (ERDF) aim at the administrative region and its counties.

2.2 Programming Region

A *programming region* consists of one or more counties within an administrative region, or a combination of adjacent counties in adjoining administrative regions or one or more administrative regions in their totality. A programming region is a clearly defined geographic area that is targeted for a particular regional development programme. Its geographic boundaries are defined such that planning objectives may be efficiently accomplished.

Programming regions are 'target regions' where specific economic policy measures can stimulate economic growth. An optimal policy for a programming region requires a clear identification of both the economic objective to be attained, and the structure of the regional economy as defined by its input-output linkages. Regional input-output structures can differ because of different technological and factor endowments. The economic effects of policy stimulation transmits growth to adjoining counties and regions, and thus affects industries through their interregional and intersectoral linkages (Boudeville, 1963).

2.3 Polarised Region

A *polarised region* is a region "… that consists of interdependencies between economic and spatial elements"[2]. 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 creates structural (compositional) inter-industry differences between these types of regions, resulting in regional income disparities.

Boudeville (1963) has argued that a polarised region should satisfy the following three criteria: i), a total population of more than four million people; ii), an integrated industrial complex; and iii), a relatively high volume of exports. Boudeville's population criterion recognises not only the

[2] Boudeville, (1963)

need for a large labour force with purchasing power, but also imposes a boundary on the minimum size of a polarised-region.

2.4 Contiguous Region

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 that regional classification will automatically result in the defining of autonomous core and periphery regions. The existence of a contiguous region with a possible 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.

2.5 Periphery Region

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." However, the European Commission (1994) describes periphery regions as national border and coastal regions with low levels of economic activity. These pre-integrated regions are peripheral because their neighbouring foreign regions have a different social, economic, legal, and political system. These differences restrict trade, and limit the complete development of interregional demand and supply linkages (Krugman and Venables, 1996).

Brülhart and Torstensson (1996) contend that a country's periphery region, such as a coastal region or border region, could also be classified as a polarised region since such regions function as trade routes with the rest of the world. Geographic distance, high transportation costs, and barriers to trade encourage the development of peripheral coastal polarised regions. Similarly, national internal border peripheral regions may become polarised regions due to an abundance of natural endowments, economic historical development, and qualitative and quantitative barriers to trade. In a pre-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.

2.6 Natural 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).

2.7 The Regional Nomenclature

The preceding discussion of region types leads to the following regional nomenclature used in this paper: a polarised region will be called a *core region*; and a contiguous region will be known as 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. The advantage of this classification lies in the ease with which it

facilitates the international comparison of the intensity of economic activity between comparable administrative regions.

3 An Agglomerate

The terminology of the new economic geography theory germinates from the seminal theoretical literature of the regional economists. In his analytical framework of industry concentration, Weber (1909) introduced the concept of 'spatial agglomerate economies' as a determining factor in the location decision of a firm. Agglomerate economies arise from the extra reduction in production, transportation, and communication costs, due to the clustering of intermediate and final goods-producing firms in one location. Transportation and communication costs are all the costs incurred through the interaction of firms with their input and output markets. These costs can be minimised if firms cluster, thereby creating economies of scale and pecuniary agglomerate advantages.

Lösch (1954), like Krugman (1978), has argued for the importance of population density in agglomerate formations.[3] He noted that,

> *'Spatial agglomeration such as, towns, are the result of agglomeration forces in both the production and consumption sphere. These agglomerative forces may be of a different nature ,for instance economies of scale, external economies, and psychological attraction forces. In this way, the general interdependent location problem is closely linked up with the analysis of urban settlement patterns.'*

Lösch also recognised the relevance of regional non-uniform utility functions. Krugman (1978), on the other hand, assumes a uniform utility function across regions. In describing and discussing Lösch's location theory, Paelinck and Nijkamp (1975) point out that,

> *'The existence of agglomerative forces leads to the concentration of different production units in one spatial point. This concentration of production is controlled by the minimisation of transportation costs within the entire industrial complex. The assumption of agglomeration advantages and of minimisation of integrated transportation costs, ... leads to bundles of industrial centres and cities, in which a maximum number of different individual production units will be located at the same place. In this way, the economic landscape will show areas with a high and a low industrial and urban concentration.'*

[3] Lösch

Lösch implicitly recognised the importance of backward and forward demand linkages in agglomerate formation. As previously stated, his use of the term 'psychological attraction forces' indicates individual regional locational utility preferences for both management and labour (Ludema and Wooton, 1997). Lösch's most salient contribution is the explicit recognition of the role of large urban centres.

The theoretical economic geography literature is replete with the term agglomeration forces and multi-agglomerate production structures (Krugman, 1991a; 1991b; Fujita, Krugman, Venable, 1999; Baldwin *et.al.,* 2000). Agglomeration forces focus on home markets. Although the term home market has never been clearly defined in the literature, its definition is essential for conceptual and empirical clarity. Agglomeration forces[4] focus on a physical geographic location where cumulative causation creates accumulation (Venables, 1994). This paper introduces the concept of *an agglomerate***,** to define such a geographic location. An agglomerate is defined as *a region with one or more large urban population centres with respective industrial complexes.* Viewed empirically, Krugman's (1991b) home market concept is synonymous with a national core region – an agglomerate.

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

The objective of this section is to present the development of a simple three-region model that classifies a country's administrative regions into *core regions, adjacent regions*, and *periphery regions*. This section is divided into three parts. The first part focuses on the development of a Core, Adjacent, and Periphery (CAP) model. The second part defines the mathematical structure behind the CAP model. The third part explains the criteria, data, and methodology utilised in classifying the

[4] The word *agglomerate* has its origin in the Latin word *agglomeratus*, the past participle of *agglomerare,* which means to heap up, join, to gather into a ball, mass or cluster (Merriam-Webster's *Collegiate Dictionary (10th/ed),* Merriam-Webster Inc., 2000).

national regions. This classification is then used to identify and examine the distribution of these regions throughout the geography of the integrated European common market. This allows for the identification of the EU geographic core, the individual EU core regions, the adjacent regions, and the EU geographic periphery.

4.1 The Theory Underlying the CAP Model

The development of the 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 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 CAP model differs from the Venables and Limao's (2002) Heckscher-Ohlin-von Thünen theoretical model in a number of ways. One, the CAP model is a national regional 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, and not intercountry labour immobility. Four, the CAP model is a framework for measuring the endogenous forces of economic geography in a world of imperfect competition.

The similarites of the CAP model with the Venables and Limao (2002) model 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.

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 consumption and manufacturing core, and a first and second ring of regions where agricultural production is located. Von Thünen illustrated that the transportion costs of market access reduce the level of rental incomes, 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 the level of wages and incomes received will be.

In Diagram 1, the concept of administrative regions is superimposed upon Von Thünen's concentric circle model. The inner circle *A* represents the central urban area. Similarly, P_0P_1 and P_1P_2 respectively respresent the distance of the first and second rings around the core. 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 encompases, 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, for example, of two small towns, *t.* Jointly, these three regions define the CAP model. The distance from the core to the outer periphery is represented by the radius $P_0P_1P_2$.

[FIGURE 1]

The simple three-region construct in Diagram 1 presents a seamless geographic expansion of domestic regions in one direction along a radius away from the core region. If we assume that the three regions compose a single country, then this three-region construct becomes a national model of centrality with the endogenous forces of economic geography operating between three regions, conform the theoretical models of Fujita, Krugman, and Venables (1999).

The introduction of the adjacent region is significant because of its geographic location.[5] Its proximity to the core enhances its relative attractiveness for industry location versus the periphery region. The adjacent region, by definition[6], is significant for industries reliant on strong forward and backward linkages. Any wage differential, between the core and the adjacent region, compounds the attractiveness of this region for industry location, and the ability to retain profitable access to the core region.

Centrality is the CAP model's primary focus, however, at the domestic regional level, the model allows for the identification of one or more national core regions. In addition, it is readily

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[5] In the Forslid *et. al.,*(1999) paper pertaining to industry relocation, firms relocate either from the outer core to the inner core or vice-versa, and from the core to the periphery. The inclusion of an adjacent region or country eliminates this gap.
[6] For the definition of an adjacent region see Section 2.4.

transformed into a multi-region CAP model. The mathematical derivation of the national regional geographic CAP model is presented in the following section.

4.2 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:

$$U = \{upd_i \mid i = 1,...,I\} \qquad (1)$$

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 set theory, specific values of the elements from U can be assigned to the three respective subsets: C, A, and P. Let the function $\varphi(upd_i)$ be the criterion for the subset C, such that $\varphi(upd_i) \in C$. Subset C is then characterised by the following condition:

$$\varphi(upd_i) \in C \leftrightarrow upd_i \in U \cap \varphi(upd_i) \qquad \forall i \qquad (2)$$

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

$$\gamma(upd_i) \in A \leftrightarrow upd_i \in U \cap \varphi(upd_i) \cap \gamma(upd_i)\theta_{CA} \qquad \forall i \qquad (3)$$

Equation (3) states that every element upd_i, in U that satisfies the criteria $\gamma(upd_i)$ and not 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 $\gamma(upd_i)$ 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 (4) indicating that the distance between the core and adjacent regions, θ_{CA} is less than the distance between the core and the periphery regions, θ_{CP}. This also implies that the distance between a periphery and an adjacent region θ_{AP} is less than the distance between the core and periphery regions, such that $\theta_{CP} > \theta_{AP}$.

$$\gamma(upd_i) \in P \leftrightarrow upd_i \in U \cap \varphi(upd_i) \cap \gamma(upd_i)(\theta_{CP} > \theta_{CA} \geq \theta_{AP}) \qquad \forall i \qquad (4)$$

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

$$\exists \quad C \cup A \cup P(\theta_{CP} > \theta_{CA} \geq \theta_{AP}) = U \qquad \forall i \qquad (5)$$

and

$$\exists \quad C \cap A \cap P(\theta_{CP} > \theta_{CA} \geq \theta_{AP}) = \varnothing \qquad \forall i \qquad (6)$$

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 (6). The universal set of regions can be rewritten as follows:

$$U = \bigcup_{j=1}^{J} R_j \qquad \forall i \qquad (7)$$

Then one may write,

$$U = \bigcup_{j=1}^{J} R_j = C \cap A \cap P(\theta_{CP} > \theta_{CA} \geq \theta_{AP}) = \varnothing \qquad \forall i \qquad (8)$$

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:

$$U = \bigcup_{j=1}^{J} R_j = \sum_{j=1}^{C} C_j \cap \sum_{j=1}^{A} A_j \cap \sum_{j=1}^{P} P_j (\theta_{CP} > \theta_{CA} \geq \theta_{AP}) = \varnothing \qquad (9)$$

This equation states that for any country *U* the union of its administrative regions is equal to the sum of its economic 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.

4.2.1 Multi-Region CAP Model – A CAP cluster.

The basic CAP model, as illustrated in Diagram 1, is composed of three regions extending outward along a radius consisting of a core, an adjacent, and a periphery region. It is, however, entirely possible that there is more than one adjacent region within the first concentric circle around the core. Likewise, the second concentric circle can consist of more than one periphery region. These theoretical possiblities create a multi-regional CAP model as is illustrated in Diagram 2.

[FIGURE 2]

In Diagram 2, seven regions are superimposed on von Thünen's concentric circles surrounding a central region, *C.* There are four adjacent regions within the first concentric circle around the core. The four adjacent regions are respectively labelled as: *bcih, hijk, kjde,* and *bcde*. The three periphery regions in the second concentric circle are labelled as: *abef, ghef,* and *ghba*. A single core region with

more than one adjacent and one periphery region is defined as a CAP cluster, which is mathematically expressed as: [7]

$$CAP_j = C_j \cap \sum_{j=1}^{A} A_j \cap \sum_{j=1}^{P} P_j(\theta_{CP} > \theta_{CA} \geq \theta_{AP}) = \varnothing \qquad (10)$$

where, 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 θ. The expression in brackets states that the distance from the core to the periphery θ_{CP} is greater than the distance from the core to the adjacent θ_{CA}, and the distance from the adjacent to the periphery θ_{AP} is greater than, or equal to the distance from the core to the adjacent. The symbol $\varnothing$ indicates that the regions are non-overlapping.

The CAP cluster is a multi-region CAP model. 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, as illustrated in Diagram 1. 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 CAP_j clusters, each with a varying number of regions. An individual country then becomes the sum of its CAP_j clusters, expressed as follows:

$$U_i = \sum_{j=1}^{CAP} CAP_j = \sum_{j=1}^{C} C_j \cap \sum_{j=1}^{A} A_j \cap \sum_{j=1}^{P} P_j(\theta_{CP} > \theta_{CA} \geq \theta_{AP}) = \varnothing \qquad (10a)$$

[7]Equation (10) is developed from equation (9). Each CAP cluster is a union of administrative regions around a core region that form a non-overlapping collective.

where the geographic dimension of country U_i is the sum of its 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 country with a 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 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, between the core region of Liege and the adjacent region of Namur.

4.3 Data, Criteria, and Methodology

4.3.1 Data

The source of the data used for the analysis of the EU regions is the Eurostat (1993) publication *Portrait of the Regions*, Vol. 1 – 4. This publication provides the most uniform data for the EU 15 Member States. However, the data is not completely uniform across all regions for a number of reasons: German Unification was completed in October 1990, and Finland, Austria, and Sweden were admitted to the EU in 1995. For the former East German Länder, the data was supplemented by information from the European Commission publication, (1994), *EC Regional Policies, Competitiveness and Cohesion,* while various Eurostat publications *REGIONS - Statistical Yearbook* have provided missing data for the other countries. The regions of all Member States have an identification code at the NUTS 1, NUTS 2, and NUTS 3 levels.[8] Although the regions of Ireland have a NUTS 2 code, the regional data is not published on a consistent basis. The same is true for Denmark. This study employs regional data at the NUT 2 level for 1989 and 1990.

[8] NUTS is Eurostat's acronym for 'Nomenclature of Territorial Units for Statistics'.

The publication, *Portrait of the Regions*, provides information on geographic, demographic, and economic variables. Data pertaining to these variables is available at the provincial, regional, and county levels. Each region is subdivided into its counties. The county level provides information on the urban areas in each county, and thus the region in its totality. In each administrative NUTS 2 region the number of urban centres are classified by total population categories of one hundred thousand or greater, fifty thousand or greater, and twenty thousand or greater. This information facilitates the identification of the major urban centres in an administrative region. The urban population density per square kilometre statistic is provided for each major city in an administrative region. The regional population statistic – population per square kilometre – is a population density measure for each county in the region, and the region in its totality. It includes the population in urban and rural districts.

4.3.2 Classification Criteria

In the Labour Force Survey of 1998, Eurostat[9] introduced the concept of urbanisation and urban areas for each region. Three types of regions are defined according to their degree of urbanisation. Although they have been somewhat modified, this analysis has made use of these definitions. 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* 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].[10] A region with a *low* population density is characterised as having less than 100 people per square kilometre and does not border on an intermediate area. However, this analysis will not make use of the Eurostat definition of a low population region. Alternatively, any region that does not border on a densely populated region, but only on an intermediate region, will be referred to as a periphery region.

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[9] Eurostat, *Statistics in Focus: Regions, 1998 (4)*
[10] Author's insertion and modification.

This study uses the following regional definitions for 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.[11] 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 / km^2. 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 greater or less than 100 people per square kilometre.

4.3.3 The Methodology for Classifying the Regions

The analysis in this section is based on the CAP model set out in equations (1) - (9). To begin the analysis of the economic geography of the EU with the CAP model, this section identifies and classifies the *core, adjacent,* and *periphery region*s within the individual EU Member states. Regional classification is based on a region's urban population density, which complies with the theoretical criterion of large market demand. This analysis adopts the Eurostat definition for the size of an urban agglomerate and uses it to classify the individual NUTS 2 regions of a country.

The urban agglomerate definition defines the minimum criterion for the population density value of a core region. Once the core regions are identified, the urban population densities of the remaining regions can be found. Any adjoining region or first-ring region around the core that does not satisfy the primary definition must be an adjacent region. In terms of concentric-circle theory, an adjacent region is called a first-order contiguity region.

A second-order contiguity region is a region in the second circle of regions around a core region and is called a periphery region. The spatial geographic distance from the core region to adjacent region (θ_{CA}) is less than that of the core region to the periphery region, (θ_{CP}). Therefore, although the minimum urban density value identifies the element in the subset core region, all the

[11] Eurostat definition.

elements with a lower value are contained in the subset adjacent and periphery regions. The determining criterion for an element to be contained in the periphery subset is distance.

Given the criterion for the elements of the subsets of the *C*, *A*, *P* regions, the empirically specified values defined in Section 4.3.2 are substituted in each subset. For the core regions from equation (2):

$$C = \{\varphi(upd_i) \in C \mid \varphi(upd_i) \geq 500\} \quad (2a)$$

where *C* represents a core region with an urban agglomerate equal to or greater than 500 people per square kilometre.

Similarly, from equation (3) for an adjacent region,

$$A = \{\gamma(upd_i) \in A(\theta_{CA}) \mid 20 \leq \gamma(upd_i) < 500\} \quad (3a)$$

This indicates that a first order contiguous region contains an urban area with a minimum population density of 20 but less than 500 people per square kilometre.

The criterion for a periphery region – a second order contiguous region – is identical to that of an adjoining region, but differentiated from it by the distance criterion. From equation (4) we obtain:

$$P = \{\gamma(upd_i) \in P(\theta_{CA} < \theta_{CP}) \mid 20 \leq \gamma(upd_i) < 500\} \quad (4a)$$

Although the criterion for the adjacent region is theoretically identical to that of the periphery region, the distinction between the two is determined by geographical distance from the core region. A periphery region is, per definition, two regions removed from a core region. It is distinguished from the adjacent region by definition and by the distance criterion.

The CAP model has postulated 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 (10) as follows:

$$CAP_j = C_j \cap \sum_{j=1}^{A} A_j \cap \sum_{j=1}^{P} P_j(\theta_{CP} > \theta_{CA} \geq \theta_{AP}) = \varnothing \qquad (10)$$

To obtain a three-region CAP model, this analysis assumes that $j = 1$, and rewrite equation (10) to include the theoretical regional criteria as follows:

$$CAP_1 = \varphi(upd_i) \in C_1 \cap \gamma(upd_i) \in A_1 \cap \gamma(upd_i) \in P_1(\theta_{CP} > \theta_{CA} \geq \theta_{AP}) = \varnothing \qquad (11)$$

This expression (11) 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.

4.3.5 Region and Urban Classification Outcomes

The classification procedure is based on the urban population density of cities in the administrative regions as revealed by actual urban and demographic survey data. The regions are then classified into core, adjacent, and periphery. The classification outcomes are listed in Table 1. The major classifications of core, adjacent, and periphery are subcategorised into six types of core regions,

four types of adjacent regions, four types of periphery regions, and four types of island periphery regions.

The following regional notation identifies the region types:

$$R = \varphi(x, y)$$

where the symbol *R* refers to region type: *C, A, P*, and *IP* as defined by the subset function φ, the variable *x* equals the subset's minimum population density criterion, and *y* represents the number of urban areas in the region that meet the criterion. The *y* values representing the number of urban areas are not included. Table 1 illustrates the generic classification of the regions. In the regional notation, there is an inverse relation between the increasing values of *x* and the declining values of $\varphi(upd_i)$ exceeding the criterion for that subset.

[FIGURE 3]

The classification of the regions proceeds in the following manner. If $x = 0$, the region is classified as an official (Eurostat) single city core region *C* or monocentric region, with no agricultural production. For example, Brussels is a *C*, which indicates it is an official region with an urban area whose size is equal to that of the county/region. If $x = 1$, and $y = 0$, the core region is symbolised by *C*1 indicating that the region consists of a number of contiguous urban areas, with no agricultural production, such as Greater Manchester, which is classified as a *C*1 region.

A core region, such as Düsseldorf is classified as *C*2:5 where $x = 2$, and $y = 5$. This indicates that the core region of Düsseldorf has an urban population density equal to or greater than 2,000 people per square kilometre ($x \geq 500 = \varphi(upd_i)$). It consists of five urban areas, each of which satisfies, but significantly exceed, the criteria for that subset (See Table 1A). The core regions of West Yorkshire (UK), Schwaben (D), and Lombardi (I), are classified as *C*3:1, since they consist of one urban area with a population density of at least 1,000 people per square kilometre but less than 2,000. A *C*3:5 classification represents a core region, such as North Holland (NL), composed of five urban areas with a population density of 1,000 people per square kilometre but less than 2,000. Finally, the

core regions Niederbayern (D) and Oost Vlaanderen (B) are classified as *C*4:5, indicating five urban centres with a population density of more than 500 people per square kilometre but less than 1000.

The symbolism used in the CAP model thus reflects two important characteristics of a region, namely, urban population density and the number of urban areas in the region with a similar or greater population density. The same notation is used for the adjacent and periphery regions.

The initial core region urban population density criterion is contravened in the case of a *C*5 core region. This classification symbolises a core region in an autonomous national country that has one major urban centre (agglomerate) having a population density less than 500,000. The *C*5 symbolism applies to Belfast, in Northern Ireland, and Dublin in the region called the East.

5 The Classification and Distribution of the EU Regions

The objective of this section is to classify the administrative regions into core, adjacent, and periphery regions, and to examine their distribution throughout the countries of the EU. The significance of the classification of the regions lies in the subsequent ability to identify and compare industry location and concentration before and after the complete removal of trade barriers in 1992. Unification encourages the former border periphery regions to establish interindustry and interregional economic linkages to stimulate their economic development. As such, the creation of an integrated geographic market results in a reclassification of the border periphery regions contiguous to foreign core regions.

This section focuses on regional classification, rather than on the comparison of interregional industry concentration. The former analysis must precede the latter, which becomes a topic for subsequent research. [12] The analysis in this section yields answers to several key questions. First, how many CAP regions are there in each individual member state? The answer to this query will reveal the number of CAP regions in each country, and the change in the classification of periphery regions to

[12] Core regions are agglomerates. These agglomerates are distributed throughout the individual EU countries. Identifying their location contributes significantly to the analysis of industry concentration in the EU. Furthermore, it facilitates the EU interregional comparison of regional industry structures, concentration, and specialisation.

adjacent regions as a result of unification. Second, this analysis affords us the opportunity to study the location and distribution of the regions in geographic space in order to determine the classification of regions positioned in the EU geographic periphery. Third, it allows for the exact identification of the EU geographic core, as well as the independent core agglomerates that signify a multi-agglomerate production structure (Krugman, 1991a)

The preliminary stylised facts indicate that the fifteen EU member states consist of 81 provinces, 222 regions, and 874 counties, including the regions of Denmark and Ireland, but excluding the French Dependencies. The integrated market has a total of 2,449 urban centres, of which 355 each have a total population greater than 100,000 inhabitants, 509 each with a total population greater than 50,000 inhabitants, and 1,585 with a population greater than 20,000 inhabitants.[13] Urban areas with a population less than 20.000 are not included in the above total.

The results of classifying the national regions into core, adjacent, and periphery are found in Table 2. The periphery regions are subdivided into continental and island periphery regions. The Irish and Danish regions are included.

[FIGURE 4]

The classification results reveal five salient points. One, Belgium has no periphery regions, while Denmark is a predominantly peripheral area. Two, Germany has 29 core regions and two periphery regions. Three, France consists of one core region and 15 periphery regions. Four, Greece, Ireland, Austria, Finland and Sweden respectively have only one core region. Five, the countries with the highest relative number of core regions are the UK, Belgium, the Netherlands, Germany, and Italy. There is some change in regional classification after EU integration in 1992. This consists primarily of the change of border periphery regions into adjacent regions.

5.1 EU Geography *Ex Ante* 1992

To address the issue of how the classification of regions changed after the removal of trade barriers (i.e. Europe 1992), a more detailed overview of the regional classification is necessary.

[13] Portrait of the Regions (1993)

Although the information in Table 2 provides a comprehensive overview of regional classification, Table 3 presents a more detailed view that considers the urban population density criteria. Table 3 represents the regional classification of a *segmented* Europe, as was the case before the signing of the Maastricht Treaty in 1992. The column numbers of Table 3 correspond to those of Table 2.

[FIGURE 5]

5.1.1 Core Regions

Europe is comprised of seventy-two core regions, varying in population density and number of urban areas. Of these, nine are single city core regions *C*. Three of these single city core regions are located in Germany. The UK has three multiple city core regions *C*1. There are sixteen core regions *C*2 with urban areas whose population density exceeds 2,000 people per square kilometre, of which twelve are located in Germany. Germany also has the most *C*3 core regions with an urban population density that exceeds 1,000 people per square kilometre. A third of the total core regions consists of regions with urban agglomerates *C*4 of 500 or more, but less than 1,000 people per square kilometre; seven of these are found in the UK, five in Belgium and four in Germany. There are four *C*5 core regions with urban agglomerate whose population density is less than 500 people per square kilometre. These agglomerates are found in Ireland, Northern Ireland, Finland, and Sweden.

5.1.2 Adjacent Regions

There are a total of sixty-nine adjacent regions in the individual countries that form the first order contiguity circle of regions.[14] There are three adjacent regions, *A* that surround a core region. This type of region is characterised by towns and cities with a very low (< 20/km^2) population density, where the core region attracts all economic activity. For example; in Belgium, Vlaams-Brabant surrounds Brussels; in Germany, the region of Brandenburg surrounds the core city-region of Berlin; and in Austria, the region of Niederösterrech surrounds the region of Vienna. Of the sixty-nine adjacent regions, forty-two have urban agglomerates *A*1 with a population density between 100 and

[14] The term 'first-order contiguity' refers to the first concentric circle around the core region.

499 people per square kilometre. The UK dominates this category with fourteen such regions, followed by Italy with seven and Belgium with four.

There are seventeen adjacent regions *A*2, with urban centres where the population density lies between 50 and 99 people per square kilometre. Finally, the data reveals seven adjacent regions *A*3 with one or more urban areas, each with population densities less than 50,000. These regions can become potential growth regions because of their connectivity to a core region.

5.1.3 Periphery Regions

In the European geographic common market, there are eighty-one periphery regions subdivided into sixty-eight continental and thirteen island periphery regions. Of the sixty-eight continental periphery regions *P*1 that border on an adjacent region, more than half have urban areas with a population density greater than 100, but less 500 people per square kilometre. France dominates this category with twelve such regions, followed by Austria with half as many. Of Denmark's six periphery regions *P*2, one or more urban centres have a population density exceeding 50, but less than 100 people per square kilometre. Of the ten *P*3 periphery regions, with an urban population density great than 20 but less than 50 thousand people per square kilometre, four are found in Ireland. Finally, the six *P*4 periphery regions, with urban population densities less than 20 thousand people per square kilometre, consist of the two adjacent periphery regions of Ita-Suomi and Pohjois-Suomi in Northern Finland, the three adjacent peripheral regions of Norra Mellansverige, Mellersta Norrland, and Övre Norrland, that stretch into Northern Sweden; the Scottish Highlands, and the Islands in the UK. It is significant to note that in pre-integrated Europe, France had the largest number of periphery regions in the EU.[15]

5.1.4 Island Periphery Regions

In total, there are thirteen peripheral-island-regions under EU administration. Of these, eight have urban centres *IP*1 with total populations of 100,000 or more. The second set of peripheral-island-

[15] Periphery regions are predominantly agricultural, which explains France's policy position in the EU Common Agricultural Policy discussions.

regions *IP*2 is primarily composed of the Grecian Islands of Voreio Aigaio and Notio Aigaio. Of these two, the former has two urban centres with a total population of 50,000 or more, while the latter has only one. Finally, both Finland and France have a peripheral island region in the *IP*4 category. The French island of Corsica has two urban centres, each with a total population less than 20,000. In contrast to this, the Finish peripheral island region of Åland, which lies halfway between Finland and Sweden, does not have an urban centre at all.

5.2 EU Geography *Ex Post* 1992

Europe 1992 desegmented the European markets by removing non-tariff barriers. Table 4 shows the reclassification of periphery regions into adjacent regions after the removal of these barriers. The reclassification pertains to those member state's peripheral-border-regions that border on foreign core regions before the removal of trade barriers.

[FIGURE 6]

Without these trade barriers, such periphery regions fall into the first concentric circle of the foreign core region, thereby changing their classification to that of an adjacent region by virtue of the concentric circle definition of regions. Their connectivity[16] to a foreign core region encourages the spread of economic linkages (Krugman and Venables, 1996). These regions can now evolve into growth regions, since they provide an expansion path for industry wishing to relocate out of the core. Alternatively, the regions become target regions for new firms wishing to locate close to a core region. Reclassification has resulted in the creation of eighteen new adjacent regions, and the elimination of an equal number of periphery regions. Furthermore, the number of adjacent regions has increased from sixty-nine to eighty-seven, with the major additions occurring in the *A*1 category.

The major beneficiary of the reclassification has been France, where the status of seven of its twelve periphery regions changed, because of their contiguity to the core regions of Belgium, Spain, Germany, and Italy. In the other EU member states, the following changes in classification from

[16] Given the similarity in the population density elements in the subsets *A* and *P*, as specified by equations (3a) and (4a), a periphery region's connectivity to a core region eliminates the distance criterion from the equations for these regions. Therefore, by virtue of the similarity in the subset criterion elements, the periphery regions are respectively classified into adjacent regions.

periphery to adjacent regions took place. In Denmark, the region of Sønderjylland became an adjacent region to the German core region of Schleswig-Holstein. In Spain, Galicia changed status, since it borders on the Portuguese core region of Norte. Similarly, in Ireland, the regions of the Northwest and Donegal now border on the core region of Northern Ireland. In the Netherlands, the two periphery regions of Groningen and Drenthe border on the German core region of Weser-Ems. In Austria, integration reduced six periphery regions to one. Specifically, the Austrian regions of Voralberg, Tirol, Salzburg, and Oberösterreich now border on the core regions of the German province of Bayern, while Kärnten borders on the Italian core region of Friuli-Venezia Giulia. Finally, in Sweden the periphery region of Sydsverige borders on, and is connected by a bridge to the Danish core region of Copenhagen. Each of these instances highlights the relationship between the removal of trade barriers and the reclassification of these regions.

Integration has left the number of core regions, and the number of periphery island-regions, unchanged. Only the number of adjacent regions has increased. No reclassification of regions occurred in Belgium, Luxembourg, Germany, Greece, Italy, Portugal, Finland, or the UK. The most salient effect of integration and reclassification has been the transformation of the Austrian regions from periphery into adjacent regions. Its significance lies in the fact that these regions form part of the EU geographic core, which consists primarily of contiguous core regions, with adjacent regions serving as buffer regions between them. The reclassification is significant for subsequent analysis of industry relocation and the creation of possible new input-output structures in the former periphery regions. It is reasonable to expect income growth in these newly classified regions.

5.3 The Geographical Distribution of the Regions

The second classification issue pertains to the question of how the regions are distributed in geographic space. It is of interest to know the location and distribution of the regions not only per individual member state, but also for the geographic market in its totality. This is relevant since not all border regions are by definition periphery regions (Brülhart and Torstensson, 1996). In Table 5, the regions have been categorised according to the criteria of their geographic location.

[FIGURE 7]

The Single City Regions meet the dual criteria of: one, official classification, and, two, the absence of agricultural employment. The *Interior Non-Border / Coastal Regions* are regions that do not have a coastline or border on an EU or non-EU State. The *Non-Coast Borders on Member EU State* are those regions without a coastline that border on a pre-integration foreign region. The second group of border-regions is the *Non-Coast: Borders on Non-EU Country*. These regions border on the former East European countries. The final group on the EU continent is the *Regions with a Coastline*. The *Island Regions* are removed from the continent.

The significance of this distribution pertains primarily to the border and coastal regions listed in columns (3), (4), and (5). The analysis indicates that each of these clusters of border and coastal regions contain core, adjacent, and periphery regions. Because a particular region may qualify for both categorisations, the above distribution contains some double counting. The *Non-Coastal: Bordering on a Member State* group contains eighteen core, and twenty-two adjacent regions respectively. The cluster *Non-Coastal: Bordering on a Non-EU-Country* contains six core regions and five adjacent–regions.[17] Finally, the group *Regions with a Coastline* shows twenty-eight core regions, thirty-five adjacent regions, and fifty periphery regions. These three clusters demonstrate that a region's geographic location does not pre-determine its classification type.

6 Agglomerations and the EU Geographic Core

This section examines the concept of the EU geographic core (Krugman and Venables, 1990) and answers the question; 'How many adjoining core regions form the EU geographic core, and where are they located?'

The EU geographic core is formed by fifty-two of the seventy-two core regions of its member states. In addition to this, there are fourteen individual adjacent regions serving as buffers between the major core clusters. The geographic core stretches in an arc through continental Europe creating a

[17] The identification of these regions is significant for their potential economic influence on the former East European regions when they become members of the EU.

north – south divide. As shown in Table 1A, in the Appendix, the geographic core finds its beginning on the Western UK coast, with the cluster of adjoining core regions consisting of Merryside, Greater Manchester, and west and south Yorkshire. The multiple urban core region of West Midlands is surrounded by adjacent regions; however, it leads to the largest UK cluster of adjacent core regions with Greater London as its turning point to the South. The adjacent region of Kent serves as the UK thoroughfare to the core regions of the European continent. On the continent, the core regions of the Netherlands and Belgium provide a core region continuum to similar regions in western Germany.

The French administrative region of Ile-De-France is France's only core region. The adjacent regions of Picardi and Champagne-Ardenne connect Ile-De-France in the north via Namur to the Belgian cluster of core regions. Ile-De-France is an offshoot of the contiguous adjoining EU geographic core regions. It, and its surrounding adjacent regions of the Basin Parisian flank the southern regions of the geographic core. Furthermore, they serve as a thoroughfare from the UK to the southwestern German core regions.

The European geographic core finds its largest concentration in the adjoining core regions located in the six western, southwestern, and southern German provinces. In the west, the cluster of Dutch geographic core regions extends into the German Province of Nordrhein-Westfalen, with the core region of Düsseldorf as its centre. From Nordrhein-Westfalen, the geographic core extends north into the Province of Niedersachsen, and east into the Province of Hessen. The province of Rheinland-Pfalz borders on the two provinces of Saarland and Baden-Württemberg. All the regions in these two provinces are adjoining core regions. To the East of Baden-Württemberg lies the southern German Province of Bayern, with its cluster of adjoining core regions, which extend to the northern border of Austria. Of the fifty-two core regions that form the EU geographic core, Germany contributes a geographic continuum of twenty-five core regions, which constitutes 48% of the geographic core. Since Düsseldorf, in Germany, is a core region with five urban agglomerates each with a population density greater than 2,000 per square kilometre, this region is assumed to be the centre of the geographic core.

The corridor of the east-west Austrian adjacent regions of Kärnten, Salzburg, and Tirol, function as thoroughfares from the eastern and western core regions of Bayern, and the entire geographic core, into Northern Italy. The southern extremity of the EU geographic core is found in the northern regions of Italy.

In contrast to the other EU states that form a part of this geographic core, Italy does not have a cluster of adjoining core regions. Instead, northern Italy contains three core regions, each separated from the other by an adjacent region. For instance, in the Northeast, the core region of Liguria is separated from the core region Lombardia by the adjacent region of Piemonte, while in the northwest the core region of Friuli-Venezia Giulia is separated from Lombardia by the adjacent region of Veneto.

Since core regions are agglomerates, it can be concluded that the EU manufacturing belt consists primarily of the agglomerates in the countries that signed the Treaty of Rome in 1957. Since then, the manufacturing belt was extended to include the UK, with its densely populated manufacturing regions giving the continental manufacturing belt its current characteristic banana shape.

Identifying the geographic core is significant because it highlights the EU's largest population density continuum. The new trade theory posits that manufacturing locates in proximity to its final markets. The classification of the composite core regions of the geographic core allows us to study the industrial complexes in these regions. Alterations and developments in their size and composition will provide key indicators, which can be utilised to assess the degree to which economic integration has induced manufacturing to relocate to the EU geographic core or to disperse away from it (Midelfart *et. al.,* 2000).

7 Agglomerates Outside the EU Geographic Core

The EU geographic core creates a north-south divide of the European common market with twenty independent urban agglomerates located in the northern and southern regions. The issue of the independent agglomerates is meaningful because of their industrial composition and stability

(Krugman, 1991a; Krugman and Venables, 1996). The independent agglomerate-regions are listed in Table 2A, in the Appendix.

Table 2A illustrates that the urban agglomerates of Bremen, Hamburg, and Berlin lie immediately north of the geographic core, as does the urban agglomerate of Kiel in Schleswig-Holstein. In Denmark lies the core region of Copenhagen, which serves as a conduit to Sweden and its core region of Stockholm. The core region of Uusimaa in Finland, with Helsinki as its capital, is the most northern EU core region. The core regions of Stockholm and Uusimaa are exceptions to the definition of urban agglomerates as applied to the other EU regions.

In the northern UK, the contiguous core regions of Northumberland-Tyne & Wear and Cleveland- Durham form a cluster of core regions quite far removed from the centre of the geographic core. To the northwest lie the independent core regions of Northern Ireland, and the East in Ireland, with respectively Belfast and Dublin, as their urban agglomerates. The independent agglomerates of Madrid, Cataluna, and Pias Vasco in Spain, and Norte and Lisbon in Portugal are situated in the south of the EU geographic core. Located to the south – east are the independent agglomerates of Lazio and Campania in Italy; and Attiki in Greece.

The identification of the EU independent agglomerates is significant because of the potential negative effects of trade liberalisation. The stability of independent agglomerates depends significantly on their industrial structure. These agglomerates are subject to possible changes in industry composition that affects their manufacturing base, employment structure and income creation because of economic integration (Krugman and Venables, 1996). Any reduction in the size of the individual industrial complexes in these agglomerates will substantiate the theory that industry is relocating to the geographic core, thereby potentially affecting the stability of the independent core regions.

8 Demographic and Economic Analysis of the EU CAP Regions

European integration has created a common market consisting of countries characterised by CAP type administrative regions exhibiting a national multi-agglomerate production structure. The objective of this section is to examine the applicability of the regional CAP structure to the EU

geographic common market. The introduction of the adjacent region provides a continuum of production locations between the core and periphery regions. Each region type should reflect a vector of demographic and economic variables, whose values are in harmony with the theme of von Thünen's (1842) concentric circle theory.

The following statistical analysis is a general assessment of the CAP theory by applying it to the EU regions as they are classified by region type. The CAP structure is a model of national regional centrality. All countries in the union have CAP type regions. The CAP region types represent the true population of EU core, adjacent, and periphery regions. The objective of the statistical analysis is twofold. First, to determine whether the data supports von Thünen's concentric circle theme, and hence, the CAP structure in the countries of the common market. Second, whether the economic geography effects of trade liberalisation are evident in changes in regional demographic and economic data *ex ante* and *ex post* EU 1992. The analytical outcomes are expected to provide preliminary answers to theoretical issues raised in the new economic geography literature (Krugman, 1991b).

8.1 Methodology

Each administrative core, adjacent, and periphery region is described by characteristic vector of demographic and economic data. The following data series is used for each of the EU administrative region types: population density (total regional population divided by the region's square kilometre geographic area), total population, the index of regional per capita income in PPS, and the structure of the labour force in each region (percentage distribution of labour employed in agriculture, manufacturing, and services)[18]. The average value of each data series for each of the region types is calculated.

Economic integration has created a new larger geographic market with multiple CAP regions. By summing over all the countries in the union equation (9) becomes the following:

[18] The data source is listed in Section 4.3.

$$EU = \sum_{i=1}^{U} U_i = \sum_{i=1}^{U} \sum_{j=1}^{C} C_{ij} \cap \sum_{i=1}^{U} \sum_{j=1}^{A} A_{ij} \cap \sum_{i=1}^{U} \sum_{j=1}^{P} P_{ij} (\theta_{CP} > \theta_{CA} \geq \theta_{AP}) = \varnothing \qquad (9a)$$

where *EU* represents the total geography of the economic union as the sum of the individual countries U_i where $i = 1\ldots,U$, and U is the total number of countries in the union. The variable C_{ij} represents the j^{th} core region in the i^{th} country; A_{ij} is the j^{th} adjacent region in the i^{th} country, and P_{ij} the j^{th} periphery region in the i^{th} country. The condition ($\theta_{CA} < \theta_{CP}$) holds for all periphery regions in the union.

To calculate the average values, let R_{ij} represent the j^{th} core, adjacent, and periphery region in the i^{th} country in the EU. Each R_{ij} has a characteristic vector of demographic and economic variables represented by, $x_{k,ij} = [x_{1,ij} \ldots\ldots x_{K,IJ}]$, where $x_{k,ij}$ is the k^{th} variable in the j^{th} region type in the i^{th} country. Taking each region type from the right hand side of equation (9a) and dividing through by the total number of region types *j,* we obtain the following expressions for average variable values:

$$\bar{x}_k^C = \frac{1}{C} \sum_{i=1}^{U} \sum_{j=1}^{C} C_{ij}(x_{k,ij}) = \bar{x}_{k,ij},\ \bar{x}_k^A = \frac{1}{A} \sum_{i=1}^{U} \sum_{j=1}^{A} A_{ij}(x_{k,ij}) = \bar{x}_{k,ij} \text{ and } \bar{x}_k^P = \frac{1}{P} \sum_{i=1}^{U} \sum_{j=1}^{P} P_{ij}(x_{k,ij}) = \bar{x}_{k,ij} \qquad (9b)$$

where, $\bar{x}_k^C, \bar{x}_k^A,$ and $\bar{x}_k^P$ represent the average values of the k^{th} variable in the core, adjacent and periphery regions. The calculated average values for each of the region types are found in Table 6. In Table 6, the row entitled 'EU 15 Averages' refers to the calculated average values for all the EU regions of the variables; index of regional per capita income (PPS), and the regional structure of employment. The outcomes of the demographic data are found in columns (2) and (3). The outcomes of the economic data are found in columns (4) and (5).

8.2 Demographic Developments

The EU demographic data in Table 6, column (2), reveals a declining regional population density structure, as regions are located further away from the core. This outcome is salient because it supports the basic theoretical assumption underlying von Thünen's concentric circle theory. The average population densities in the EU CAP regions increased marginally in 1997. The core regions

have collectively experienced a net increase of over five and a half million people. The adjacent regions experienced a net total increase of one and a half million people over the same period. Surprisingly the periphery regions did not experience a collective net decline in their total population. To the contrary, they experienced a net population increase of six hundred and ten thousand people resulting in a higher *ex post* 1992 population density. Only the island periphery regions revealed a population outflow.

[FIGURE 8]

These results are important from an economic geography viewpoint, since they lend support to the theory of the home market and the competition effect on population (labour) movements due to trade liberalisation (Krugman, 1991b). The EU core regions attracted the largest population inflows. The net population increase in the adjacent regions was approximately one quarter of the increase in the core regions. Seventy-nine percent of the total EU adjacent regions experienced population growth. The periphery regions also showed an increase in population growth. On balance, seventy percent of the EU periphery regions experienced positive population relocation.

Since labour is domestically mobile (Krugman, 1991b) in pursuit of employment opportunities, relocation of labour to national periphery regions implies the development of self-sustaining economic activity and long-term income opportunities in these regions.[19] This is a significant development for three reasons. One, it provides evidence of the success of the new EU regional policies in preventing the export of unemployment (Doyle, 1989). Two, it provides some evidence to support the theory of cumulative causation starting from very low initial levels of capital accumulation (Krugman and Venables, 1996). Three, it supports the theories of diversified agglomeration (Venables, 1994; Ludema and Wooton, 1997; Forslid and Wooton, 1999).

8.3 Economic Developments in the CAP Regions

The new economic geography trade theory assumes that manufacturing will locate where its markets are largest, but its markets are largest where population density is highest (Krugman, 1991b).

[19] This study has not examined international population migration. The data, however, appears to support the theories of Venables (1994) and Ludema and Wooton (1997) that labour in the EU is imperfectly mobile.

Regional economic theory further assumes that per capita incomes are highest in the core regions and decline progressively along the radius extending to the periphery (von Thünen, 1842). The decline in income is the result of the transport intensity of manufactured products (Venables and Limao, 2002). The higher the transport intensity of a product, the closer the location of its production will lie to the regional core, and the less manufacturing production will occur in the periphery. With the removal of trade barriers, some manufacturing will relocate from the periphery to the core resulting in increased unemployment in the periphery regions. On the other hand, the relative wage differential between the core and periphery regions will attract capital investment to the latter (Venables, 2000).

The previous section has illustrated the inverse relationship of population densities and distance in the regional CAP model. Given this fact, it is reasonable to expect the existence of a positive relationship between the levels of per capita income and a region's CAP classification. This section addresses two questions. First, is there a significant difference between the levels of per capita income in the CAP regions, and has convergence or divergence of income levels occurred? Second, how has the structure of employment in the CAP regions changed over time?

8.3.1 Income Differences in the CAP Regions

The average per capita incomes[20] for the CAP regions are presented in Table 6. The EU 15 average per capita income value is the mean value of the annual index of regional per capita income. The average level of per capita income for the entire EU geographic market increased by 3.0% from 92.3% in 1990 to 95.3% in 1997. The average levels of per capita income as reported for the individual CAP regions reveal different levels for the CAP region types. The average level of per capita income is highest in the core regions and lowest in the island periphery regions. These are promising outcomes that support von Thünen's concentric circle theory of a positive relationship between regional population density and per capita income that underlies the CAP model.

[20] Regional per capita income is an annual indexed variable used to rank and compare the per capita income development of the regions.

To answer the question, "Is there a significant difference between the levels of per capita income in the CAP regions?" the Tukey-Kramer Procedure[21] is used to determine whether the average per capita income levels of the CAP regions are significantly different from each other. The Tukey-Kramer Procedure is a single factor analysis of variance procedure to determine which means, in a set of c means, are significantly different from each other given unequal sample sizes. Table 6 reports the average levels of per capita incomes calculated for four samples of unequal size – the core, adjacent, periphery and periphery regions – for four different periods.

The Tukey-Kramer procedure permits a concurrent examination of comparison between all pairs of CAP average per capita income means in a given year. The null hypothesis states that there is no difference among the average per capita income levels in a given year. The alternative hypothesis states that not all means are equal. For the data observations on each year, the Sum of the Squares Within (*SSW*) groups was calculated. This allowed a determination of the Mean Square of the Sum Within (*MSW*) given that the number of levels in each year $c = 4$, and the total number of regions $n = 202$. The upper-tail critical value Q_U from the Studentized range distribution with $c = 4$ degrees of freedom in the numerator, and $n - c = 202 - 4 = 198$ degrees of freedom in the denominator is given to be $Q_U = 2.37$.

The results of the test are given for $c(c - 1)/2 = 6$ pairs of means for a group-to-group comparison for each year. The analysis shows that in all the group-to-group comparisons, the absolute difference between the average per capita income levels exceeds their respective critical range. The one exception is in 1995 between the means of the periphery region and the island periphery regions. In this case, the absolute difference between the means (12.2) is marginally less than the critical range (12.37), so that the null hypothesis cannot be rejected. This situation changes in the following years. The conclusion of the analysis is that the null hypothesis is rejected, and the alternative hypothesis that there is a significant difference between the average per capita levels of income in the CAP regions, is accepted.

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[21] Levine, D. Berenson, M. L., and Stephan, D., (1999), 'Statistics for Managers (2/ed)', *Prentice Hall, New Jersey.*

8.3.2 Income Convergence Between the CAP Regions

To answer the question whether there is a convergence of per capita income between all the EU regions, the measures of central tendency and variation for each of the per capita income series 1990 – 1997 is calculated. These statistics are listed in Table 7 below. A measure for the convergence of per capita income is the distribution of observations around the mean value of a variable. The wider the distribution around the mean, the more dispersed and the more dissimilar the observations will be. The narrower the distributions around the mean, the more similar are the observations. The most widely used measures of distribution around the mean are the standard deviation and the variance of the observations. Hence, the smaller the standard deviation, the smaller the variance, and the more similar the numerical values of the observations will be.

[FIGURE 9]

The statistics in Table 7 provide some evidence for the convergence of per capita incomes between the regions. First, both the standard deviation and the variance are decreasing in each of the years under consideration. The change in the variance over the period 1990-1997 is -21.7%. Further evidence of convergence is provided by the coefficient of variation that declines by 14.5%. Second, from 1995 to 1997 the value of the interquartile range declined from 31.0% to 28.2%. The interquartile range consists of 50% of the ordered observations of the variable. Since this value range is declining over the years, the statistic suggests that the mid-range of values of 50% of the observations have declined. This means that there are more observations within that 50% range with a similar value, and that regional per capita income convergence has taken place. It does not indicate, however, in which CAP regions the largest convergence has occurred.

To assess which of the CAP regions have contributed the most to the convergence of per capita incomes, the measures of central tendency and variance are calculated for each of the cluster of regions in the model. The changes in four of the summary statistics are presented in Table 8.

[FIGURE 10]

The core region shows an increase of 15.7% in the size of the interquartile range, indicating an increase in the diversity of per capita incomes. This increase is offset by the substantial decline in the

value of the interquartile range of both the periphery (-19.0) and the island periphery (-10.8) regions over the period 1990–1997. The largest reduction in the sample variance over this period occurs in the periphery (-353.3) and the adjacent (-194.4) regions. This suggests that the largest convergence of per capita incomes occurred in the periphery regions, followed by the adjacent regions, with a minor contribution by the core regions. The change in the relative values of the coefficient of variation supports this conclusion.

The outcome of the empirical analysis indicates that both the EU average level of per capita income, and that of the individual CAP region types, has increased over the period under consideration. Furthermore, it is also evident that a difference exists between the average levels of per capita income between the CAP regions. However, this difference is declining due to the convergence of per capita income between the periphery and the adjacent regions. This convergence of per capita incomes can only be the result of increased employment in the periphery regions, and provides a reason for the mitigation of out-migration from these regions.

8.3.3 The Structure of Employment in the CAP Regions

The structure of employment is defined as the percentage distribution of the labour force employed in agriculture, manufacturing, and services. The regional employment structure for the years 1990 and 1998 is presented in Table 8. In general, the average EU structure of employment changed between 1990 and 1998. During this period, there was a relocation of the labour force out of employment in the agricultural and industrial sectors and into the service sector. This pattern of relocation is consistent for all CAP region types.

The new economic geography trade theory receives support from the evidence that industrial employment is concentrated in the core regions, and agriculture employment in the periphery regions (Krugman, 1991a, 1991b). The highest percentage of industrial employment is located in the core regions and the lowest in the island periphery regions. It is also evident, that agricultural employment is lowest in the core regions and highest in the island periphery regions. Agricultural employment

increases with distance from the core as von Thünen's concentric circle theory predicts. The inverse is true for industrial employment.

The policy effects of economic integration and the new regionalism are visible in the direction of change in the employment structure. The parallel effect of these policies was to restructure regional agricultural and industrial employment. Employment in agriculture declined in all CAP regions with the smallest decline occurring in the core regions and the largest in the island periphery regions. The elimination of barriers to trade resulted in a decline in industrial employment in *all* the EU CAP regions. This decline in industrial employment, however, is smallest in the periphery regions. Similarly, the increased employment in the service industry is highest in the periphery regions, followed closely by the island periphery regions. These two developments support the observations that out-migration from the periphery regions is being mitigated by new employment opportunities primarily in the service industry.

The objective of this section was to examine whether developments in regional demographic and economic data could be analysed within the framework of the CAP model at the EU regional level. The stylised facts lend initial support to the forces of the new economic geography theory. The CAP model provides preliminary evidence of the presence of agglomeration and dispersion forces at the EU regional level. The home market effect is visible in population migration primarily to the EU core regions, as theory predicts (Krugman, 1991b). The competition effect is evident in population migration to the adjacent and periphery regions.

Furthermore, per capita income is highest in the core regions and declines sequentially in the adjacent and the periphery regions. There is a significant difference in the average levels of per capita income between the CAP region types, with some income convergence between the adjacent and periphery regions attributable to the competition effect. The structure of regional employment is changing with labour moving out of the agricultural and manufacturing sectors and into the service sector.

Through the inclusion of the adjacent region, the CAP model shows that population density, per capita income, and manufacturing employment decline gradually with distance from the core

region. Agricultural employment increases in regions more distant from the core, as von Thünen's (1842) concentric circle theory predicts.

9 Conclusions on National Regional Geography

This paper has developed and presented an empirical model of national economic geographic centrality based on von Thünen's (1842) concentric circle theory. The model is significant because it defines and categorises national regions according to predefined and accepted criteria. The model allows for the application of the Eurostat definition of an *urban agglomerate* to administrative regions. This application facilitates the identification of core regions within a country. The core region, by definition, is a measure of centrality, representing a degree of localised geographic urbanisation and concentrated demand. Since manufacturing locates where demand is highest, we have found these core regions to show the highest levels of manufacturing employment concentration. This fact supports the theory that the core is an attraction region. The identification of the core regions is significant for the further study of agglomerations and industry concentration.

The regional CAP classification has permitted a preliminary analysis of the endogenous forces of economic geographic theory (Krugman, 1991b) on a regional level that departs from the conventional national aggregate empirical analysis of Forslid *et al.* (1999), Davis and Weinstein (1998), and Midelfart *et al.,* (2000). The CAP model is an extension on the research of Davis and Weinstein (1999) and provides a more tangible regional analytical framework because it defines the economic characteristics of the regions and empirically classifies them.

The classification procedure identifies the border periphery regions that will receive direct economic impulses from trade liberalisation. This is especially true for periphery regions that border on foreign core regions. The identification of these regions will facilitate the study of the degree of income convergence or divergence of these regions because of integration (Krugman and Venables, 1996), which is also of interest for the border regions of the East European nations that will join the European Union.

The straightforward statistical analysis of the economic data for the total population of CAP region types across the EU economic geographic area supports von Thünen's concentric circle theory of an inverse spatial geographic relationship of declining per capita incomes and distance from a central location. The theoretical foundations of the CAP model are supported by the positive relationship between the spatial location of population density and per capita income. These salient outcomes are revealed by the introduction of an adjacent region at the national level. The introduction of this third region provides a seamless spatial continuum of geographic locations for economic activity.

The inter-temporal data analysis reveals the CAP structure to be constant. The developments of the economic and demographic variables provide preliminary evidence of the theoretical forces of the home market and competition effects as described in the new economic geography theory (Krugman, 1991b). The dynamics released by the forces of economic integration seem to initially affect the core agglomerates within a country, spread to the lower cost adjacent regions, and into the periphery regions.

Subsequent research should explore the effects of trade liberalisation on industry (re)location and concentration in the CAP clusters of national economies. The research should focus on the characteristics of industries (Midelfart *et. al.,* 2000) that locate in the region types as well as the geographic location of regions and their characteristics that enable them to attract industry types.

APPENDIX

[FIGURE 11]

[FIGURE 12]

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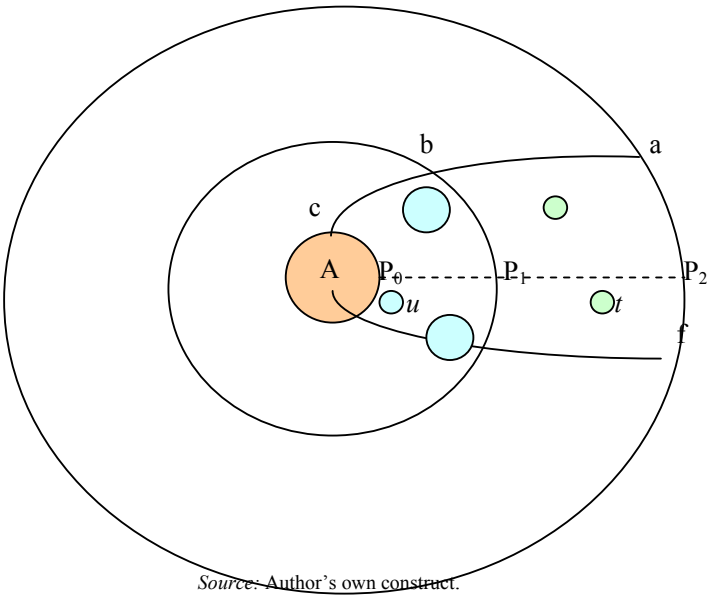
[FIGURE 1]

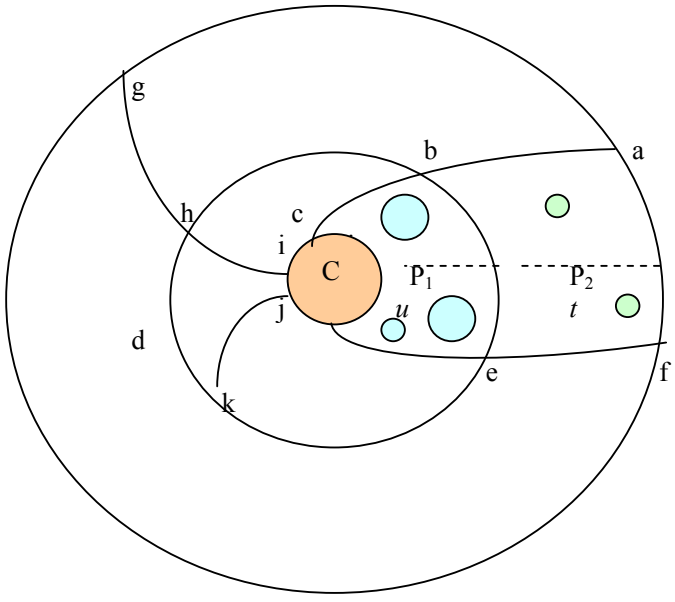
DIAGRAM 1
RELATIONSHIP BETWEEN CONCENTRIC CIRCLES AND REGIONS



Source: Author's own construct.

[FIGURE 2]

DIAGRAM 2
RELATIONSHIP BETWEEN CONCENTRIC CIRCLES AND REGIONS



Source: Author's own construct.

[FIGURE 3]

TABLE 1
CLASSIFICATION OF NUTS 2 REGIONS INTO: CORE, ADJACENT, PERIPHERY, AND ISLAND PERIPHERY

DESCRIPTION OF AREA TYPES		
CORE		
1	C	= a single city region
2	C_1	= multiple city region with no employment in agriculture
3	C_2	= contains one or more urban area's (UA) with a population density ≥ 2 thousand / km^2
4	C_3	= contains one or more urban area's with a population density ≥ 1 thousand / km^2
5	C_4	= contains one or more urban area's with a population density ≥ 500 / km^2
6	C_5	= a single national urban area with a population density (PD) < 500 / km^2
ADJACENT		
7	A	= any adjacent region which completely surrounds a core region
8	A_1	= any region adjacent to a core with one or more UA's with a PD between 100 – 500 / km^2
9	A_2	= any region adjacent to a core with one or more UA's with a PD between 50 – 99 / km^2
10	A_3	= any region adjacent to a core with one or more UA's with a PD less than 50 / km^2
PERIPHERY		
11	P_1	= a region bordering on an adjacent or other periphery with one or more UA's with PD ≥100 / km^2
12	P_2	= a region bordering on an adjacent or other periphery with one or more UA's with PD ≥ 50 / km^2
13	P_3	= a region bordering on an adjacent or other periphery with one or more UA's with PD ≥ 20 / km^2
14	P_4	= a region bordering on an adjacent or other periphery with one or more UA's with PD < 20 / km^2
ISLAND PERIPHERY		
15	IP_1	= a peripheral island region with one or more UA's with a PD ≥100 / km^2
16	IP_2	= a peripheral island region with one or more UA's with a PD ≥ 50, / km^2
17	IP_3	= a peripheral island region with one or more UA's with a PD between 20 – 49 / km^2
18	IP_4	= a peripheral island region with one or more UA's with a PD < 20 / km^2

Source: Author's own regional classification format. *UA* = urban area; *PD* = population density

[FIGURE 4]

TABLE 2
EU 15 REGIONAL CLASSIFICATION 1990

(1)	(2)	(3)	(4)	(5)	(6)	(7)
N	Country	C	A	P	IP	Total
1	Belgium	6	5			11
2	Denmark	1	3	9	1	14
3	Germany	29	7	2		38
4	Greece	1	2	6	4	13
5	Spain	4	7	5	2	18
6	France	1	5	15	1	22
7	Ireland	1	3	4		8
8	Italy	5	11	2	2	20
9	Luxembourg		1			1
10	Netherlands	5	4	3		12
11	Austria	1	1	7		9
12	Portugal	2	2	1	2	7
13	Finland	1	1	3	1	6
14	Sweden	1	1	6		8
15	UK	14	16	5		35
	Total	72	69	68	13	222

Source: Author's own calculation.

[FIGURE 5]

TABLE 3
DETAILED EU 15 REGION CLASSIFICATION 1990

(1)	(2)						(3)					(4)					(5)					(6)	(7)
N	Country	C	C1	C2	C3	C4	C5	TC	A	A1	A2	A3	TA	P1	P2	P3	P4	TP	IP1	IP2	IP3	IP4	TPI	Total
1	Belgium	1			5			6	1	4			5					0						11
2	Denmark			1				1		2	1		3	3	6			9		1			1	14

3	Germany	3		12	10	4		29	1	5		1		7	2				2								38
4	Greece					1		1				2		2	1	4	1		6	2	2					4	13
5	Spain	1		1		2		4		2		3	2	7	3	1	1		5	2						2	18
6	France	1						1		2		3		5	12	3			15					1		1	22
7	Ireland						1	1				1	2	3			4		4								8
8	Italy			1	2	2		5		7		4		11	1		1		2	2						2	20
9	Luxembourg							0		1				1					0								1
10	Netherlands	1		1	1	2		5		4				4	3				3								12
11	Austria	1						1	1					1	6		1		7								9
12	Portugal				2			2		1			1	2		1			1	2						2	7
13	Finland						1	1					1	1			1	2	3					1		1	6
14	Sweden						1	1					1	1	2		1	3	6								8
15	UK	1	3	1	1	7	1	14		14	2			16	3	1		1	5								35
	Total	9	3	16	17	23	4	72	3	42	17	7		69	36	16	10	6	68	8	3	0	2			13	222

Source: Authors own calculations.

[FIGURE 6]

TABLE 4
DETAILED EU 15 REGIONAL RE-CLASSIFICATION 1997

(1)	(2)							(3)					(4)					(5)						(6)	(7)
N	Country	C	C1	C2	C3	C4	C5	TC	A	A1	A2	A3	TA	P1	P2	P3	P4	TP	IP1	IP2	IP3	IP4		TIP	Total
1	Belgium	1				5		6	1	4			5												11
2	Denmark				1			1		2	**2**		**4**	3	**5**			8		1				1	14
3	Germany	3		12	10	4		29	1	5	1		7	2				2							38
4	Greece					1		1			2		2	1	4	1		6	2	2				4	13
5	Spain	1		1		2		4		**3**	3	2	**8**	**2**	1	1		4	2					2	18
6	France	1						1		**9**	3		**12**	**5**	3			8					1	1	22
7	Ireland						1	1			1	**3**	4			**3**		3							8
8	Italy			1	2	2		5		7	4		11	1		1		2	2					2	20
9	Luxembourg							0		1			1												1
10	Netherlands	1		1	1	2		5		**6**			**6**	**1**				1							12
11	Austria	1						1	1	**5**			**6**	**1**		1		2							9
12	Portugal				2			2		**1**		1	**2**		1			1	2					2	7
13	Finland						1	1				1	1			1	2	3				1		1	6
14	Sweden						1	1		1		1	2	**1**		1	3	5							8
15	UK	1	3	1	1	7	1	14		14	2		16	3	1		1	5							35
	Total	9	3	16	17	23	4	72	3	**58**	**18**	**8**	**87**	**20**	**15**	**9**	6	**50**	8	3	0	2		13	222

Source: Author's own calculations.

[FIGURE 7]

TABLE 5

GEOGRAPHIC DISTRIBUTION OF THE REGIONS

		Interior	Non-Coast	Non-Coast	Regions with a Coast-line				
		Single City	Non-border / Coastal	Borders Member	Borders Non- EU		Bordering on:		Island	Total Country
Nr.	Country	Regions	Regions	EU State	Country	Total	EU State	Non EU States	Regions	Regions
	Euro 15	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1	Belgium	1	3	7		1	2			11
2	Denmark			1		13			1	14
3	Germany	3	17	12	6	5	2	1		38
4	Greece		1		1	8		3	4	13
5	Spain	2	3	4		9	4	1	2	18
6	France	1	5	5	3	10	5		1	22
7	Ireland			1		7				8
8	Italy		1	3	4	13	1	1	2	20
9	Luxembourg		1	1						1
10	Netherlands	1	1	5		6	2			12
11	Austria	1		5	7					9
12	Portugal					5	4		2	7
13	Finland				1	4		3	1	6
14	Sweden					8		4		8
15	United kingdom	6	11			24				35
	Total Regions	15	43	44	22	113	20	13	13	222
Average (Y/P) PPS 1990		118.8	103.3	102.5	96.4	87.6			65.8	92.3
Average (Y/P) PPS 1997		120.7	104.6	104.5	100.1	89.7			71.7	95.3

Source: Authors own calculations.

[FIGURE 8]

TABLE 6
DEMOGRAPHIC AND ECONOMIC CHANGES IN THE EU CAP REGIONS: 1989 - 1997

								Region's Structure of Employment					
Regions	Population Density (x 1,000)		Change in Total Pop. (x 1,000)	CAP-Model Averages. Index of Regional Per Capita Income (PPS)				Agriculture (%)		Manufacturing (%)		Services (%)	
(1)	(2)		(3)	(4)						(5)			
CAP-Model 202	1990	1997	90 – 97	1990	1995	1996	1997	1990	1998	1990	1998	1990	1998
EU 15 Averages				92.3	94.9	95.1	95.3	8.7	6.3	31.5	38.6	59.7	64.8
CORE 72													
Net Total			5830.0										
Average	768.1	787.0	81.0	106.7	110.1	109.9	110.1	4.0	2.7	33.5	29.7	62.7	67.3
Standard Deviation	1149.2	1167.0	94.1	26.2	27.2	25.5	25.3	4.1	2.3	8.7	8.4	10.5	9.3
ADJACENT 79													
Net Total			1522.0										
Average	152.0	162.8	19.3	89.4	91.2	92.1	92.5	9.0	6.5	32.6	29.7	58.6	63.7
Standard Deviation	117.9	125.5	83.6	23.9	19.6	19.5	19.5	9.1	6.1	7.1	6.1	10.1	8.5
PERIPHERY 39													
Net Total			610.0										
Average	68.4	72.6	15.6	78.9	80.9	80.7	80.5	14.8	10.9	28.0	26.7	56.1	62.2
Standard Deviation	47.1	52.2	69.2	26.5	19.2	18.8	18.7	12.7	8.7	5.2	5.1	14.5	8.0
ISL. PERIPHERY 12													
Net Total			-60.2										
Average	113.5	114.0	-5.0	61.6	68.7	68.8	68.6	16.5	12.4	22.8	21.2	60.4	66.4
Standard Deviation	91.3	93.6	24.8	18.5	15.1	14.1	14.7	10.8	7.7	6.1	4.5	12.4	7.4

Source: Author's own research

[FIGURE 9]

TABLE 7
MEASURES OF CENTRAL TENDENCY AND VARIATION

CENTRAL TENDENCY	***1990***	***1995***	***1996***	***1997***
Mean	92.3	94.9	95.1	95.3
Median	95.0	93.0	92.8	93.8
Mode	95.0	96.0	104.5	102.1
Midhinge	93.5	92.5	92.6	92.1
Interquartile Range	31.0	31.0	28.5	28.2
Midrange	106.5	119.0	118.5	119.8
Skewedness	-0.04	0.93	0.85	0.88
VARIATION				
Standard Deviation	28.1	25.7	24.8	24.8
Sample Variance	786.4	658.8	616.7	615.7
Coefficient of Variation	30.4	27.1	26.1	26.0
Minimum	30.0	43.0	43.8	42.5
Maximum	183.0	195.0	192.5	197.1
Count	202	202	202	202

Source: Author's own calculations

[FIGURE 10]

TABLE 8
CHANGES IN MEASURES OF CENTRAL TENDENCY 1990-1997

	CORE	*ADJACENT*	*PERIPHERY*	*ISL. PERIPHERY*
Interquartile Range	15.7	-1.7	-19.0	-10.80
Standard Deviation	-0.9	-4.5	-7.8	-127.7
Sample Variance	-47.1	-194.4	-353.3	-1.2
Coefficient of Variation	-1.6	-5.7	-10.4	-2.6

Source: Author's own calculations.

[FIGURE 11]

TABLE 1A

URBAN AGGLOMERATES AND THE EU GEOGRAPHIC CORE

				Reg.	Nr	Tot.			
			Core	Pop.	Urb	Pop.	Y/P	Y/P	
		d	Reg	Dens	Ar.	Change	(PPS)	(PPS)	
PROVINCES	N REGIONS		1997	1997		90-97	1990	1997	90-97
NORTH - WEST	1Merryside	931	C1	2166.3	9	-24.6	77	74.6	-2.4
	2Greater Manchester	855	C1	2004.9	10	-12.9	92	93.2	1.2
YORKSHIRE-	3West Yorkshire	898	C3:1	1038.9	6	43.4	95	93.8	-1.2
HUMBERSIDE	4South Yorkshire	847	C4:1	838.1	4	10.9	80	75.4	-4.6
	5Derbyshire, Nottinghamshire	783	A1:2	417.5	13	49.2	92	93.1	1.1
	6Shropshire, Staffordshire	828	A1:2	239.1	11	37.2	86	89.0	3.0
WEST - MIDLANDS	7West Midlands	774	C1	2938.8	6	26.1	97	94.4	-2.6
	8Hereford-Worcs., Warwick	726	A1:2	203.9	9	44.4	89	101.0	12.0
	9Leich., Northamptonshire	735	A1:2	312.8	11	60.3	107	105.5	-1.5
WALES	10Gwent, Mid-S-W-Glamoran	819	C4:2		16		82	73.9	-8.1
SOUTH-EAST-WEST (UK)	11Avon, Glouch, Wilshire	760	C4:1	282.3	11	101.4	108	114.8	6.8
	12Berks, Bucks, Oxfords	639	C4:1	362.2	12	95.6	113	126.3	13.3
	13Bed-, Herefordshire	658	C4:1	547.4	13	49.7	105	104.5	-0.5
	14Greater London	570	C	4489.7	1	316.3	154	145.7	-8.3
	15Surrey, East-West Sussex	626	C4:1	464.5	18	116.4	101	106.7	5.7
	16Kent	472	A1:1	418.8	18	38.2	92	93.7	1.7
NETHERLAND	17Noord-Holland	238	C3:5	932.8	22	104.4	118	127.6	9.6
	18Zuid-Holland	230	C2:1	1169.1	33	131.8	109	116.7	7.7
	19Utrecht	179	C	794.9	12	67.8	95	125.6	30.6
	20Gelderland	123	C4:1	379.1	27	87.3	87	100.5	13.5
	21Noord Brabant	111	A1:4	468.7	26	122.9	95	114.6	19.6
BELGIUM	22Antwerpen	212	C4:2	570.8	16	39.7	166	169.1	3.1
	23Brussels	252	C	5897.7	1	-12.1	126	138.5	12.5
	24Oost Vlaanderen	283	C4:3	454.8	17	24.3	100	104.1	4.1
	25West Vlaanderen	274	C4:1	358.7	14	21.3	107	116.2	9.2
	26Hainaut	169	C4:2	339.1	17	5.7	78	79.0	1.0
	27Champagne-Ardenne	287	A2:2	52.8	8	4.0	112	90.1	-21.9
FRANCE	28Ile de France	487	C	921.8	37	421.8	166	152.6	-13.4
	29Namur	137	A1:1	119.5	3	17.1	83	86.0	3.0
BELGIUM / NETHERLAND	30Liege	121	C4:1	263.0	10	17.8	96	98.6	2.6
	31Limburg (NL)	110	C4:1	524.4	13	33.1	94	103.1	9.1
NORDRHEIN-	32Düsseldorf	0	C2:5	996.2	42	101.2	124	115.5	-8.5
WESTFALEN	33Köln	40	C2:2	568.8	53	226.1	114	115.3	1.3
	34Munster	136	C2:1	376.6	29	162.2	96	96.5	0.5
	35Detmold	150	C3:1	313.2	21	191.5	107	102.1	-4.9
	36Arnsburg	45	C2:3	476.8	40	130.5	105	99.8	-5.2
RHEINLAND-PFALZ	37Koblenz	153	C3:1	187.3	6	134.9	95	89.7	-5.3
	38Trier	278	C4:1	103.7	1	32.5	89	93.2	4.2
	39Rheinessen-Pflaz	287	C2:1	292.2	12	155.1	114	100.9	-13.1
SAARLAND	40Saarland	348	C4:2	418.0	13	9.3	109	98.3	-10.7
HESSEN	41Darmstadt	217	C2:2	497.4	31	212.1	158	164.7	6.7
	42Kassel	225	C3:1	153.4	7	83.5	104	105.9	1.9
BADEN - WURTEMBURG	43Stuttgart	392	C2:1	369.4	33	290.1	137	130.5	-6.5
	44Karlsruhe	284	C2:1	385.3	20	181.9	123	134.1	11.1
	45Freiburg	477	C3:1	226.0	17	179.9	109	106.2	-2.8
	46Tubingen	517	C4:1	195.9	13	157	112	110.1	-1.9
NIEDERSACHSEN	47Braunschweig	246	C3:1	206.2	16	55.7	111	97.6	-13.4
	48Hanover	250	C2:1	237.5	23	116.3	115	111.4	-3.6
	49Weser-Ems	404	C3:3	160.5	23	231.9	93	102.2	9.2
BAYERN	50Unterfranken	363	C3:3	1559.0	4	94.7	98	102.1	4.1
	51Schwaben	555	C3:1	173.8	8	142.6	110	105.4	-4.6
	52Mittlefranken	452	C2:1	231.7	8	112.7	125	121.3	-3.7
	53Oberfranken	417	C3:2	154.1	7	58.1	103	106.4	3.4
	54Oberplaz	542	C3:1	110.3	6	78.1	94	96.8	2.8
	55Niederbayern	596	C4:3	112.6	4	106.1	95	101.4	6.4
	56Oberbayern	620	C2:1	228.0	14	275.7	146	164.7	18.7
	57Salzburg	759	A1:1	71.5	1	29.6	118	122.6	4.6
	58Tirol	757	A1:1	52.3	1	30.5	107	106.7	-0.3
	59Kamten	847	A1:1	59.1	2	15.4	85	89.0	4.0
	60Trentino-Alto Adage	927	A2:2	67.7	3	34.2	135	131.1	-3.9
NORTHERN - ITALY	61Friuli-Venezia Giulia	1193	C3:1	151.1	5	-17.8	122	125.1	3.1
	62Venetio	989	A1:6	242.9	26	75.8	117	123.0	6.0
	63Lombardia	876	C3:1	375.9	52	61.5	135	131.1	-3.9
	64Piemonte	936	A1:5	169.0	30	-65.6	121	116.7	-4.3

65	Liguria	1015	C4:1	303.8	11	-81.0	116	118.9	2.9

[FIGURE 12]

TABLE 2A
URBAN AGGLOMERATES OUTSIDE THE EU GEOGRAPHIC CORE

N	Code	Regions	Dist. Duss. *d*	Dist closest *Core* *d*1		Core Reg	Reg Pop Dens	Nr Urb Ar.	Tot. Pop. Change	Y/P (PPS)	Y/P (PPS)	
						1997	1997		90-97	1990	1997	90-97
1	UK13	Northumberland, Tyne, Wear	1047	99		C2:1	257.8	11	3.0	82.0	85.1	3.1
2	UK11	Cleveland, Durham	997	149		C4:1	383.2	16	15.1	85.0	81.7	-3.3
3	UKB	Northern Ireland	1246	381		C5:1	118.5	6	89.0	74.0	82.2	8.2
4	IE01	East	1045	167		C5:1	52.1	2	157.2	68.0	102.1	34.1
5	FI11	Uusimaa	1344	1241		C5:1	146.6	9	41.9	120.0	134.4	14.4
6	SE01	Stockholm	1312	593		C5:1	270.2	3	67.6	140.0	122.9	-17.1
7	DK	Copenhagen	698	241		C3:1	5289.0	2	148.4	107.0	120.3	13.3
8	DEF	Schleswig-Holstein	471	86		C2:1	175.4	18	171.1	99.0	102.1	3.1
9	DE6	Hamburg	385	106		C	2251.2	1	74.1	183.0	197.1	14.1
10	DE31	Berlin	543	284		C	3815.6	1	-11.1	116.0	109.0	-7.0
11	DE5	Bremen	363	113		C	1652.4	2	-6.1	148.0	145.0	-3.0
12	AT13	Vienna	937	398		C	3856.1	1	60.3	153.0	164.1	11.1
13	IT60	Lazio	1439	424		C4:1	303.6	27	59.2	115.0	112.6	-2.4
14	IT80	Campania	1656	217		C2:1	426.0	32	-17.4	69.0	65.2	-3.8
15	GR3	Attiki	2619	2443		C4:1	905.6	2	-74.3	50.0	75.1	25.1
16	ES21	Pias Vasco	1453	624		C4:1	283.9	12	-98.6	90.0	94.0	4.0
17	ES8	Madrid	1804	617		C	628.2	15	-5.5	96.0	101.2	5.2
18	ES51	Cataluna	1393	613		C4:1	189.9	35	-102.5	92.0	100.0	8.0
19	ES63	Ceuta y Melilla				C2:2	4244.0	2	2.7	64.0	69.4	5.4
20	PT11	Norte	2104	573		C3:1	167.0	26	100.5	49.0	64.3	15.3
21	PT13	Lisbon	2311	621		C3:1	278.0	30	7.8	76.0	92.3	16.3
		Total of Independent Core's			21				253	682.4	98.9	105.7
		Total of Geographic Core Regions			51				844	5640.8	108.4	109.9
		Total of all Core Regions				72		1097	6323.2	207.3	215.6	

* Ceuta y Melilla is excluded as an EU core region. It consists of two towns on the North African Mediterranean coast, and will be considered to be a Spanish foreign dependency. *d* = distance to Düsseldorf. *d*1 = distance to the closest core-region
Source: Authors own research. Data for Tables A2 and A3 from Eurostat