

# A Border Regions Typology in the Enlarged European Union

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**Abstract:** *The processes of European Union (EU) integration and enlargement have produced a new regional socioeconomic map in Europe. Border regions, in particular, have been put in a state of flux. The re-allocation of activities, opportunities and threats is changing their socio-economic role and significance. Thus, border regions have become an issue of great importance during the last fifteen years in both the areas of scientific research and policy making. The overall picture of the actual dynamics occurring at the border regions, however, when economic barriers have been abolished, remains rather unclear. The absence of an appropriate methodological framework for the study of the impact of EU integration and enlargement dynamics on border regions is evident.*

*The paper proposes a typology for the EU NUTS III border regions, interpreting the socioeconomic dynamics occurring within the enlarged EU space. Primary and secondary data, incorporating quantitative and qualitative determinants for border regions, were elaborated with integrated factor and fuzzy clustering analysis techniques. The proposed border regions typology provides a framework to assess the relative position of each EU border region in the EU space.*

## Introduction

Border regions in Europe have become an important issue over the last fifteen years in the areas of both scientific research and policy making. The removal of the artificial barriers to interaction in the post-1989 European economic space, the EU eastward enlargement, the overlapping of national sovereignty by multinational corporations and organizations, the resurgence in nationalism and the “disappearing of distance” due to technological advances have established new grounds for discussion on border issues (Ohmae 1990; O’Brien 1992; Amin 1997; Giddens 1999, inter alia).

“Bridge,” “wall,” “tunnel,” “opportunity,” “threat,” “borderless,” “re-bordering,” “de-bordering,” are only some of the terms concerning borders and border regions, indicating that this discussion has only just begun. As a result of these processes and

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*The authors would like to thank the participants at the 2004 ABS “Borders in a New Europe: Between History and New Challenges” European Conference for their fruitful comments and the editors of the Journal of Borderland Studies for their valuable suggestions. Research work supported by the EU 5<sup>th</sup> Framework-Program for Research and Technological Development.*

the socioeconomic dynamics generated, border regions have been put in a state of flux; the re-allocation of activities, opportunities and threats is transforming their socioeconomic role and significance.

Separate strands of scientific approach, such as location and trade theories, and political theory and international relations, are being used by scholars to deal implicitly or explicitly with issues concerning border regions, but a systematic theory of borders has yet to be developed. The overall picture of the dynamics occurring in border regions after economic barriers are abolished remains rather unclear. It rests mostly on individual pieces of empirical research (Niebuhr and Stiller 2002).

The EU eastward enlargement has brought forward not only a new political and economic map of Europe but also a new “mentality map” redefining the notion of vicinity. The systemic change in Central and Eastern Europe has engendered positive expectations of a unified Europe where borders would no longer form restricting dividing lines but opportunities for facilitating communication and interaction.

While such interactions are considered to be a prerequisite for the gradual formation of a “European identity,” it is also evident that the new European map is associated with new contradictions and divisions that create or redefine the perceptions and images of “us” and “others.” The process of EU integration “melts” the internal EU borders (e.g. the Single European Market) and “freezes” the external ones (e.g. by the Schengen Treaty).

The border regime with countries adjacent to the EU—EU Candidate Countries, the Western Balkans, the European Economic Area, the Maghreb, Russia—is highly heterogeneous. An attempt is underway to form a “ring of friends” in the context of European Neighborhood Policy, aimed at the expansion of the EU market, laws and procedures, however the polyphony of the EU policies regarding its external borders together with the divides that exist within its hinterland underline the necessity of interpreting the new dynamics of the border regions.

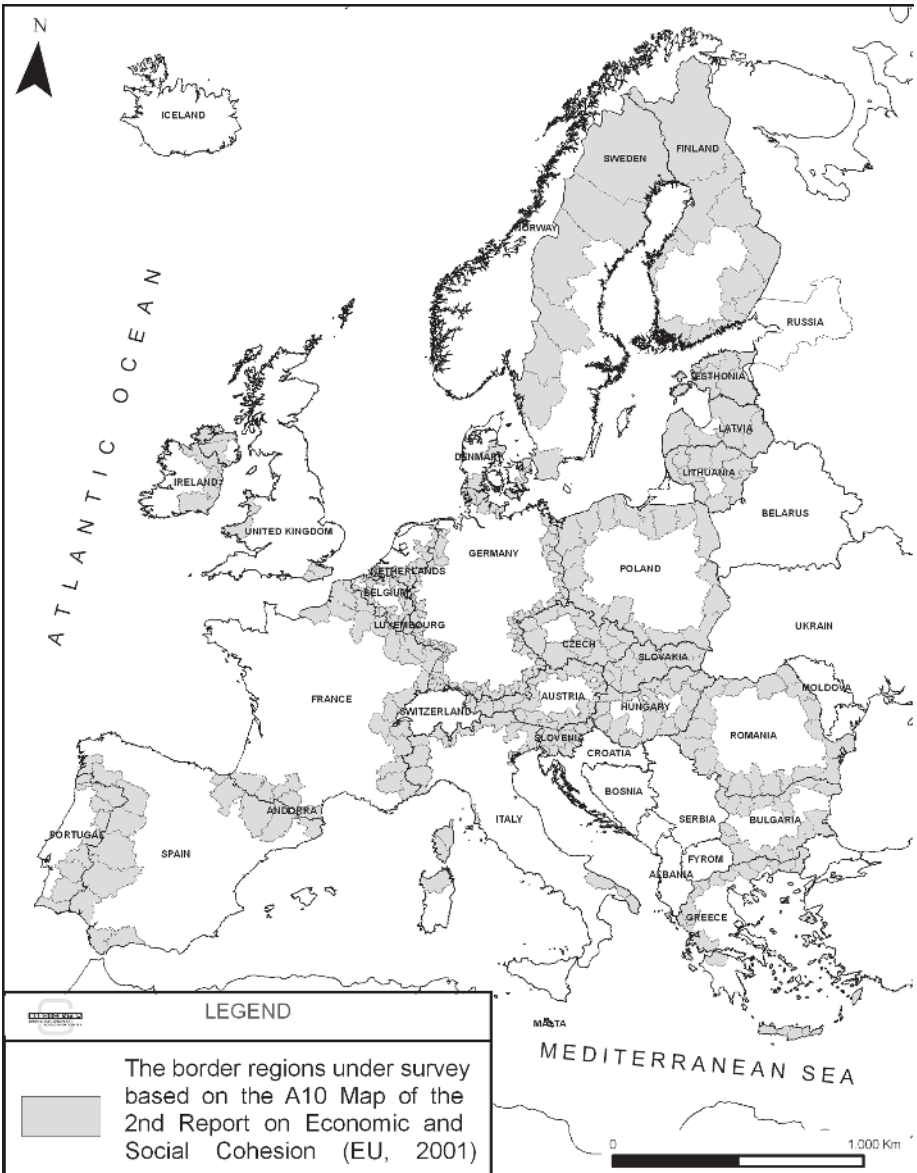
The paper proposes a typology for the 387 EU NUTS<sup>1</sup> III border regions, interpreting the socioeconomic dynamics occurring within the enlarged EU space (EU old member-states, EU new member-states except Cyprus and Malta and the EU candidate members of Bulgaria and Romania). The regions under survey are those included in the A10 Map of the 2nd Report on Economic and Social Cohesion (EU 2001), reproduced in Figure 1. The border regions typology provides a useful tool for describing the relative position of each border region in the EU space.

The paper approaches this subject by first examining and tracing the parameters used for the construction of the typology. The third section explains the methodological framework. The fourth section presents the border region typology and in the last section conclusions are drawn concerning the usefulness of the typology.

## **Tracing the Parameters for a Border Regions Typology**

The impact of EU integration on border regions ranges from “traditional” effects, like the allocation and growth of income (Baldwin and Seghezza 1996), to “non-traditional” effects, including foci like security, credibility, and coordination (Fernández 1998). The interpretation of the spatial dynamics of integration in the EU border regions based solely on economic parameters is, thus, incomplete. Selecting the parameters for a border regions typology requires the examination of both economic and

Figure 1. The Border Regions Under Survey



Source: Authors' elaboration based on the A10 Map of the 2nd Report on Economic and Social Cohesion (EU, 2001).

non-economic aspects of integration. This is not an easy task, however, as it requires the analysis of both quantitative and qualitative variables (Maier 1995).

## Economic Aspects of Integration

Economic integration eliminates border obstacles for factor movements and further intensifies itself (self-sustained process) via the reduction of trade costs (Helliwell 1998; Wallace 1998). Closed borders distort the market size whereas the consequent abolition of borders releases all kinds of spatial dynamics. These dynamics are related both to better access to foreign markets and cheaper imports enhancing the locational attraction of border regions, and to import competition from foreign firms enhancing the locational attraction of the internal regions (Brülhart, Matthieu, and Pamina 2004).

The internal EU regions, being on the whole the most advanced, in income terms, are concerned that the abolition of trade barriers and the free movement of capital may have negative implications for their economic performance due to their inability to compete successfully in terms of (low) production costs, especially in economic sectors mainly based on unskilled labor. Skepticism, nevertheless, also exists in the less advanced, border, regions regarding their ability to take advantage of the opportunities offered by economic integration, as they are thought to be poorly adjusted (in terms of economic and institutional structures, human capital and technology) to the conditions and demands of the free-market economic environment (Melachroinos 2002).

The changes in the spatial patterns of economic activity through trade liberalization can be discerned in the theoretical literature through the study of trade theories (see Brülhart 1998 for an analytical survey). Neoclassical trade theory supports the idea that economic integration leads to higher levels of economic specialization due to an increase in the demand for goods that a region is able to produce at low costs, based on inherent comparative advantages. New economic geography supports that economic activities associated with increasing returns to scale tend, at intermediate stages of economic integration, to locate at the most populous regions trying to exploit the benefits of agglomeration economies, whereas, at advanced stages of economic integration, tend to present a dispersed location patterns having ensured their access to large regions and trying to avoid the burden of agglomeration diseconomies.

Neoclassical trade theory provides a better explanation of the inter-industry type of trade, conducted mainly among economies with different productive structures, whereas new economic geography is more suited to describe the intra-industry type of trade, taking place mainly among economies with similar productive structures. Such trade activity (that takes place within rather than between industries) is more beneficial than inter-industry trade because it stimulates innovation and exploits economies of scale. It is not, thus, a paradox that almost 60% of intra-European trade is intra-industry trade with United Kingdom, France and Germany, in particular, being top importers and exporters of passenger cars (Ruffin 1999).

The externalities that characterize the EU space are of great importance (Petrakos, Psycharis, and Kallioras 2004; Petrakos, Rodriguez-Pose, and Anagnostou 2004). Mobile factors of production (i.e. capital and specialized labor) tend to be disproportionately clustered in the EU core regions that have high market access, which is translated into strong demand for the goods that they produce (Head and Mayer 2003). Conversely, the geographically disadvantaged EU peripheral regions cannot benefit as much as others from international trade because they face higher transportation costs (Limao and Venables 2001). Engaged in an integration process with distant and larger partners, these regions will tend to develop unbalanced, inter-industry trade relations, with an unfavorable impact on their industrial bases (Petrakos and Christodoulakis 1997).

Under these conditions, economies with increasing returns to scale activities might do better than the others, while less advanced ones face the possibility to become losers either in relative or in absolute terms (Petrakos 2000; Petrakos 2001).

The parameter of accessibility in the new economic geography models is associated with regional development through the idea that agglomeration economies rise due to market expansion (Monfort and Nicolini 2000; Monfort and Ypersele 2003). Economic integration triggers the agglomeration dynamics among the interacting parts, in regions with efficient market size (Amiti 1998). In a world of trade restrictions, these regions are mostly located in (or near the) capital of the country, since trade obstacles along the border areas discourage the (re)location of economic activities towards the periphery (Hoover 1963). Under free trade conditions, peripheral regions with small market size have also the opportunity of benefiting as their market size potential gets larger (Alesina, Spolaore, and Wacziarg 2000). This is especially the case when the neighboring market is larger than the internal one (McCallum 1995; Damijan and Kostevc 2002; Resmini 2002).

Market size can be considered to be a mirror of a country's urban and regional system to the extent that it reflects the allocation of economic activities among cities and regions. The size of cities and their distance from the borderlines define to a large extent the type and intensity of cross-border interaction. Large urban centers located close to border regions seem to operate as a hub of all sorts of economic activities due to their increased market size. Within this context, market size, distance and urban system represent a useful interpretative triptych of interaction among border regions when obstacles across the borders are abolished (Petrakos and Topaloglou 2005).

### Non-Economic Aspects of Integration

The notion of non-economic aspects refers to the dominant socio-cultural conditions that influence border interaction in the border regions. Taking these conditions into account, boundaries are understood not only as static lines but also as sets of practices, discourses and perceptions that affect border interaction (Paasi 1999). State borders, therefore, are mapped on (and interact with) a plethora of other socio-cultural boundaries that distinguish national, ethnic or linguistic groups (Anderson and O'Dowd 1999). Under this perspective, border regions are examined as social construction, where the role of norms, collective identities and shared memories is important in interaction (Keating, Loughlin, and Deschouwer 2003). Within this context, the disappearance of the "Iron Curtain" has not only redefined the geopolitical landscape of Europe but also brought to surface new symbolic and metaphoric meanings regarding the notions of "us" and "them."

Political theory and international relations offer valuable insights into the issues of borders. Studying the hard territorial lines that separate states, within an international system, the contemporary study of borders accentuates the process of borders' creation through which territories and peoples are included within (or excluded from) a hierarchical network of groups, affiliations and identities (Newman and Paasi 1998; Kolossov 2005). Political geographers are attempting to interpret the contemporary world that was formed along rigid boundary lines. Territorial configuration, however, that is suggested by the maps of Europe, allows for fuzzy boundaries interpretations and raises new questions concerning European integration. The efforts for abolishing border obstacles within the EU are associated with inclusion and exclusion consequences across

the European space. The traditional approach analyses borders mainly from the states' point of view, focusing on security and hierarchy at the international level, whereas the post-modern approach focuses on the crisis of the Westfalian state and the role of identity in relation to borders. Concerning the EU, in particular, it has been proposed that a neo-medieval empire model predominates, with borders being soft zones in flux with multiple cultural identities, contrasting to a post-Westfalian state type with fixed borders and distinct cultural identity (Zielonka 2001). At the same time, the neo-liberal approach argues, by contrast, the "death of the nation-state" in a "borderless world" due to globalization trends (Ohmae 1995).

The non-economic aspects that affect the dynamics occurring at border regions are related to the national, linguistic and geographic parameters. The interaction among border regions is associated with the overall perceptions formed previously among the respective countries as an interaction between national and local identity (Galasinska and Galasinski 2003). In this respect, Meinhof, Armbruster, and Rollo (2003) found that although perceptions along the east-west German borders show major differences, the sense of "German" is common, when the discussion broadens to a European level. Matters across the borders, however, are more complicated when territory and nationality do not coincide and the relationship between nation and state is ambiguous. As a result, border demarcation is sometimes an effort to fit the nation into the procrustean bed of the state or to break the states into coherent sub-units (Brubaker 1998).

Language also impacts on border interaction as even its mere accent plays a symbolic role in uniting or separating people across the borderlines, operating as an "us" or as an "us-against-them" indicator (Meinhof, Armbruster, and Rollo 2003). The importance of linguistic differences, regarding border interaction, is even greater, when minorities are present in the border regions. The use of a common language across the borders is one of the major conditions for the origin of the national, regional and cultural identity. This fact gives an in-depth account of the complex ways that language affects cross-border interaction and underlines the relationship between language and identity.

The association between economic geography and political identity in borderlands is interesting since geographic units that form distinguishing identities can be outlined in different areas (Central Europe, Balkans, Baltics) (Dittmer 2003). This phenomenon is often associated with economic characteristics that operate in a divisive manner not only in the sphere of economy but also in the area of perceptions. The EU accession referendum in Poland in June 2003 is an indicative example since in the western border regions the "yes" vote was at the level of 84% whereas the respective vote in the eastern border regions was at the level of 63% (Stiller 2003).

Even though distance loses its significance due to ongoing improvement of communication technology, it seems that a correlation occurs between geography and identities in border regions. This means that geography is still playing an important role in defining identities and interaction across borders.

Coming from the previous, the general picture may arise that border regions in general possess a unique, dynamic and maybe even singular character. At the same time, border regions are also considered to play an important role within the "European project" of integration and with that also in policies on several levels, be it regional, national or European. In this respect it would be helpful if it would be possible to deal with the very different nature of these regions. The next part therefore probes the possi-



bilities to develop a kind of typology, that would map the relative position of border regions within an expanded EU.

# Selecting the Parameters for a Border Regions Typology

A border regions typology intends to classify the enlarged EU NUTS III border regions, incorporating information on socio-economic trends and characteristics. Primary and secondary data are incorporated, capturing both the qualitative and the quantitative aspects of the EU integration forces activated in the border regions. The primary data were derived from the EXLINEA project: Lines of Exclusion as Arenas of Cooperation in Europe.<sup>2</sup> The secondary data were derived from the EUROSTAT REGIO Database ([www.epp.eurostat.cec.eu.int](http://www.epp.eurostat.cec.eu.int)) and elaborated further by the authors.

Based on the economic parameters and initial conditions described above and their relationship with the EU integration process, twelve (12) variables can be considered essential to the construction of the border regions typology. Table 1 presents the variables used for the construction of the border regions typology.

**Table 1**  
**Variables Used for the Creation of the Border Typology**

| Variable             | Name    | Units of Measurement   |
|----------------------|---------|--|
| Area                 | AREA    | Square Kilometers  |
| Population           | POP     | Inhabitants  |
| Per Capita GDP       | PCGDP   | Purchasing Power Parities  |
| Gravity              | GRAV    | Sum of distances among the centroids of each pair of regions weighted by their populations |
| Employment           | EMPL    | % of employees to the active population  |
| Secondary Sector GDP | SECGDP  | % of secondary sector in GDP   |
| Tertiary Sector GDP  | TERTGDP | % of tertiary sector in GDP  |
| Integration          | IOI     | Trade with EU15 (% of world trade) weighted by the location quotient of the industry       |
| Capital              | CAP     | Capital (=100) or not (=0)   |
| Language             | LANG    | Different language with the other side as a problem (survey; Likert scale)                 |
| Nationality          | NATION  | Different nationality with the other side as a problem (survey; Likert scale)              |
| Neighborhood         | NEIGH   | Border with EU15 region (=100) or not (=0)   |

Sources: Data from EXLINEA Project and EUROSTAT REGIO Database elaborated by the authors.

The economic integration parameter can be proxied by an index of integration (*IOI*) that describes the proportion of the trade activity with the EU15 regions (i.e. the area of the old EU member-states) to the total trade activity. The estimation of the *IOI* concerns the sector of manufacturing, the dominant sector in the international trade activity (Aiginger 2000). Since trade flows do not exist at a regional level, the *IOI* is calculated implicitly. At first, the calculation is at the national level for each of the 14 manufacturing sectors under the formula:

$IOI_i = (\text{TRADEEU15}/\text{TRADEWORLD}) * 100$ , where  $i$  denotes the industrial sector. The higher is the  $IOI_i$  the higher is the integration of the sector with the EU economy.

$$IOI_r = \sum_i IOI_i * LQ_{i,r}$$

To regionalize the index, we weight with the corresponding employment location quotient ( $LQ_{i,r}$ ) and the  $IOI$  takes its final form:

The regional  $IOI$  takes values in the interval  $[0, +\infty]$ —as the  $LQ_{i,r}$  takes values also in the interval  $[0, +\infty]$ —from no to complete economic integration.

The geographic location of each border region regarding the location of all other regions, on a pan-European scale, is given from a gravity index ( $GRAV$ ). The  $GRAV$

$$GRAV = \sum_i \left( \frac{p_i p_j}{d_{ij}} \right)$$

index is the sum of distances among the centroids of each pair of regions weighed by their populations, expressing, thus, centrality. It takes the form:

where  $p$  is the population of regions  $i$  and  $j$  and  $d$  is distance between them, and values in the interval  $[0, +\infty]$ , from no to ultimate centrality.

The level of economic activity located in a region is captured by the level of employment (EMPL) expressed as a percentage of the active population. Its significance, however, for the economic performance of regions and for the process of economic integration in general, is given by the share of industrial activity in regional Gross Domestic Product (GDP). Moreover, the GDP share of the tertiary sector is included in the construction of the typology. This sector presents strong linkages (complementarities) with industrial activity (Aiginger 2000).

The development level of each region (PCGDP) was expressed in per capita Purchasing Power Parities (PPP), which measures how much a currency can buy in terms of an international measure. Goods and services have different prices in different countries, thus facilitating the international comparisons of living standards. The size of each region (AREA) is expressed in square kilometers and its population (POP) in inhabitants.

Two dummy variables were also taken into account. The first one indicates whether a region has borders with a EU15 region. In this case the region takes the value of 100, since the EU15 is the most integrated area of the enlarged EU, whereas if this is not the case, it takes the value of 0. The second dummy variable indicates whether a border region is the capital region of a country. In this case the region takes the value of 100, since it enjoys the agglomeration economies of a capital. If this is not the case, it takes the value of 0.

The significance of the language (LANG) and the nationality (NATION) parameters were assessed by means of a questionnaire carried out in 9 different EU cross border areas within EXLINEA Project. A total of 939 respondents, coming from both the public and the private sector, were asked to indicate whether differences between border regions constitute a problem concerning cross-border interaction. The answers were given in a Likert scale in the range from 1 (serious problem) to 7 (important asset).

For purposes of correspondence, all variables used for the construction of the border regions typology were normalized in the interval  $[0, 100]$ .



Data Methodological Framework and Interpretation

For the construction of the border regions typology, factor and fuzzy clustering analysis methods are employed. The socioeconomic parameters that explain the economic and non-economic aspects of EU integration (discussed in the previous section) create synthetic hyper-variables, concerning the EU NUTS III border regions. The regions under analysis were classified in groups according to the characteristics they present in terms of the previously created hyper-variables.

Data Reduction Using the Method of Factor Analysis

Factor analysis was employed in order to explain variability among a number of observable random variables in terms of a smaller number of unobservable random variables, called factors or hyper-variables, maintaining the maximum level of useful information (Rogerson 2001). The principal component analysis was used to apply the factor analysis method. It represents the linear combination that captures the greatest proportion of the variability of the dataset. The different combinations of the variables are expressed by the eigenvalues (i.e. the extraction sums of square loadings). The eigenvalues are chosen to be higher than 1 because otherwise the variance of their errors is almost non-interpretable.

Table 2 reveals that the first five (5) components extracted under the principal component analysis method present eigenvalues higher than 1 and explain 80.354% of the variance of the original variables, a proportion that is quite satisfactory.

Table 2  
Total Variance Explained Under the Principal Components' Extraction Method

| Component | Total | Initial Eigenvalues |              |
|-----------|-------|---------------------|--------------|
|           |       | % of Variance       | Cumulative % |
| 1         | 2.847 | 23.726              | 23.726       |
| 2         | 2.463 | 20.526              | 44.252       |
| 3         | 1.896 | 15.800              | 60.052       |
| 4         | 1.313 | 10.940              | 70.992       |
| 5         | 1.123 | 9.362               | 80.354       |
| 6         | 0.787 | 6.558               | 86.913       |
| 7         | 0.608 | 5.064               | 91.977       |
| 8         | 0.324 | 2.701               | 94.679       |
| 9         | 0.229 | 1.906               | 96.585       |
| 10        | 0.205 | 1.707               | 98.292       |
| 11        | 0.122 | 1.016               | 99.308       |
| 12        | 0.008 | 0.692               | 100.000      |

Source: Authors' elaboration

It was evident that in each component some variables present high (in absolute terms) degrees of participation, at least significantly higher than the rest of the variables included. The communalities of each variable (i.e. the degree each variable was captured in the each component) are presented in Table 3.

**Table 3**  
**Creation of Hyper-Variables**

|         | Components |            |            |           |            |
|---------|------------|------------|------------|-----------|------------|
|         | 1          | 2          | 3          | 4         | 5          |
| SECGDP  | 0.930      | 7.577E-02  | 9.801E-02  | 2.565E-02 | 6.282E-02  |
| TERTGDP | -0.867     | 0.327      | 6.611E-02  | 0.130     | -2.340E-02 |
| IOI     | 0.856      | 0.250      | 7.286E-02  | 0.115     | -9.496E-02 |
| PCGDP   | -6.694E-02 | 0.866      | 6.379E-02  | 0.190     | 0.153      |
| EMPL    | 0.195      | 0.708      | -0.115     | 6.976E-03 | -0.190     |
| NEIGH   | -0.106     | 0.679      | 9.875E-03  | 0.475     | -4.639E-02 |
| GRAV    | 6.059E-02  | 4.386E-02  | 0.971      | 3.018E-02 | -4.857E-02 |
| POP     | 3.745E-02  | -8.519E-02 | 0.966      | 3.751E-03 | 7.701E-02  |
| LANG    | 1.858E-02  | 5.073E-02  | 7.735E-02  | 0.910     | -6.126E-02 |
| NATION  | 3.122E-02  | 0.335      | -5.809E-02 | 0.862     | 0.117      |
| CAP     | -3.389E-02 | 0.157      | -1.813E-02 | -0.147    | 0.837      |
| AREA    | 3.596E-02  | -0.217     | 4.244E-02  | 0.169     | 0.712      |

Source: Authors' elaboration

These communalities after rotation (Varimax) led to the creation of five (5) hyper-variables. The created hyper-variables are presented in Table 4. Each has a positive meaning since each initial variable has a positive meaning also (measured from low to high or from negative to positive). So, the high presence of each hyper-variable in a region is desirable.

**Table 4**  
**The Factor Analysis' Hyper-Variables**

| Hyper-Variables | Variables Included   |
|-----------------|----------------------|
| STRINT          | SECGDP, TERTGDP, IOI |
| ECON            | PCGDP, EMPL, NEIGH   |
| MARKET          | POP, GRAV            |
| QUAL            | LANG, NATION         |
| AGGL            | AREA, CAP            |

Source: Authors' elaboration

The first hyper-variable (STRINT) is comprised of variables related to the structural patterns of each border region and its degree of integration with the EU15. It turns out that border regions that manage to retain a significant portion of their industrial bases, despite increased competition due to the abolition of trade barriers, are considered to present high levels of integration with the EU15 area since the majority of trade activity is conducted in industrial goods. Regarding this, high GDP shares of the tertiary sector have a favorable impact. This sector presents positive linkages with industrial activity, at least in the majority of cases.

The second hyper-variable (ECON) is comprised of variables that describe the economic characteristics of each border region. Border regions located inside or near the EU15 area seem to enjoy higher levels of economic performance and higher levels

of employment, since they manage to escape from the economic isolation that they suffered before the abolition of trade barriers.

The third hyper-variable (MARKET) is comprised of variables related to the market dynamism and potential of each region described by its geographical position and population. Border regions that are closer to large markets and are large markets themselves present highest ability or potential to attract both production factors and consumers.

The fourth hyper-variable (QUAL) incorporates the qualitative variables of the dataset, stressing their significance to the analysis of the border regions spatial dynamics. The perceptions and identities along the borders themselves (regarding language and nationality) comprise a critical parameter that affects to a great extent their economic and social status.

The fifth hyper-variable (AGGL) includes the variables that describe the ability of each border region to attract economic activities into its area due to its size and functions. Border regions that are capital regions (e.g. Tallinn, Vilnius, Bratislava) enjoy the benefits of agglomeration economies that all capital and metropolitan regions also enjoy.

The above extracted hyper-variables are confirmed by the significance and the interaction of the initial variables of the dataset in the theoretical literature, especially in regard to the new economic geography theory.

### Border Regions Typology with Fuzzy Cluster Analysis

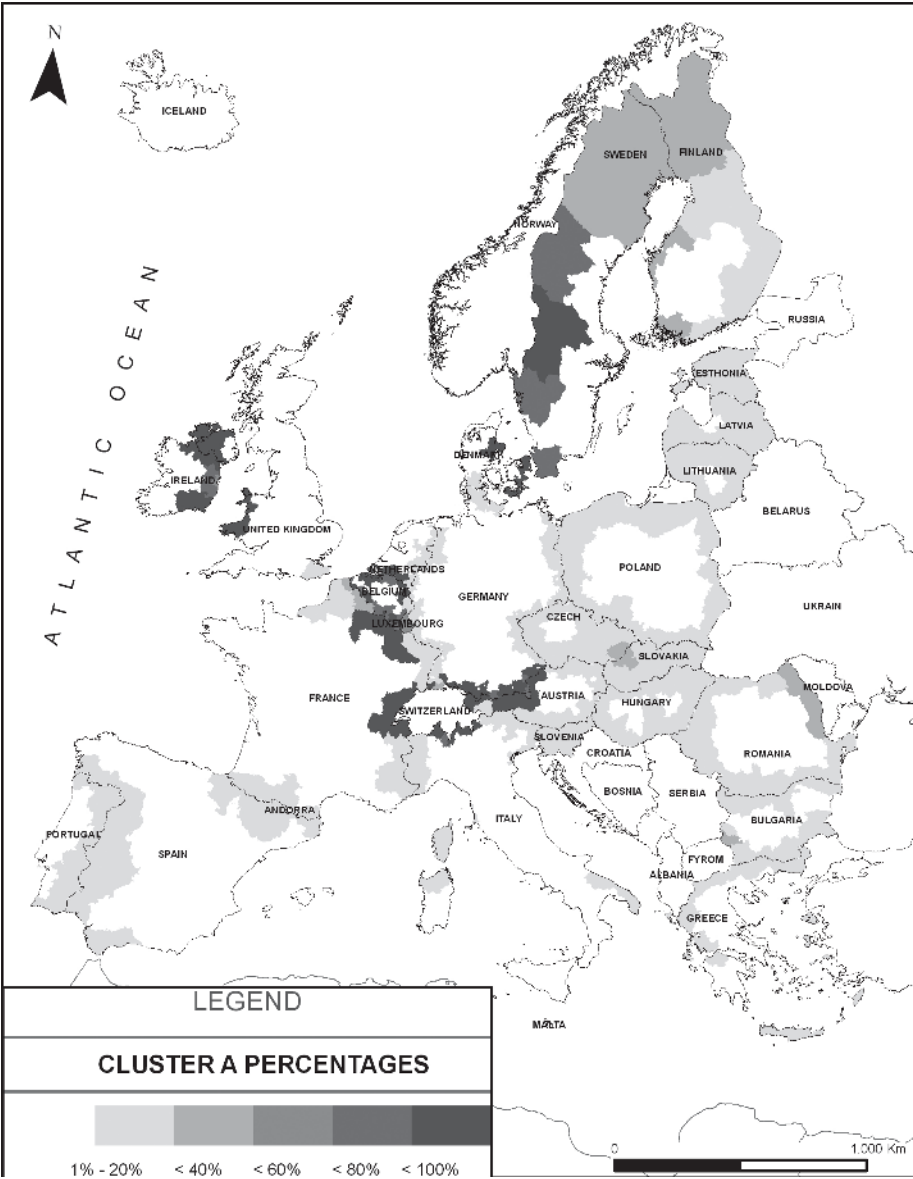
Reality is complex, however, and cannot be always depicted adequately in a binary, "yes or no," way. The fuzzy clustering approach is, thus, preferred since regions may share characteristics that belong to different hyper-variables. Fuzzy clustering is a classification technique aiming to identify whether individual units (border regions) belong into different groups (clusters) by making multiple quantitative comparisons (Kosko 1994). In this case, each region is attributed to each cluster by a percentage, instead of attributing to only one cluster as it occurs in traditional approaches.

Fuzzy c-means (FCM) algorithm (Bezdek 1981) was applied for the fuzzy clustering of the dataset. The method allows fuzzy classifier to be created and structures (clusters) in data to be searched for. That is, for each variable in the dataset a cluster center value is created. Each cluster's interpretation is represented by the cluster center values for each variable. This means that when a cluster center value is high, then that cluster is characterized by this attribute (variable). By comparing the cluster centers' values, an interpretation can be given for each group of units. The algorithm starts with an initial guess for the cluster centers, which are intended to mark the mean location of each cluster. The initial guess for these cluster centers is, most likely, incorrect. Additionally, it assigns every data point a membership grade for each cluster. By iteratively updating the cluster centers and the membership grades for each data point, FCM iteratively moves the cluster centers to the right location within the data set. This iteration is based on minimizing an objective function that represents the distance from any given data point to a cluster center weighted by that data point's membership grade. For the selection of the optimal number of clusters, reliability criteria of the fuzzy clustering were used, according to the contemporary literature (Chiu 1994; Photis and Manetos 2003). These criteria include partition coefficient, proportion exponent and classification entropy. They measure the quality of clustering by assigning a value to it, in that

the more the data points are concentrated around the cluster centers, the better the cluster structure, the higher the value. The overall philosophy is to minimize variations within clusters and maximize variations between them (Rogerson 2001).

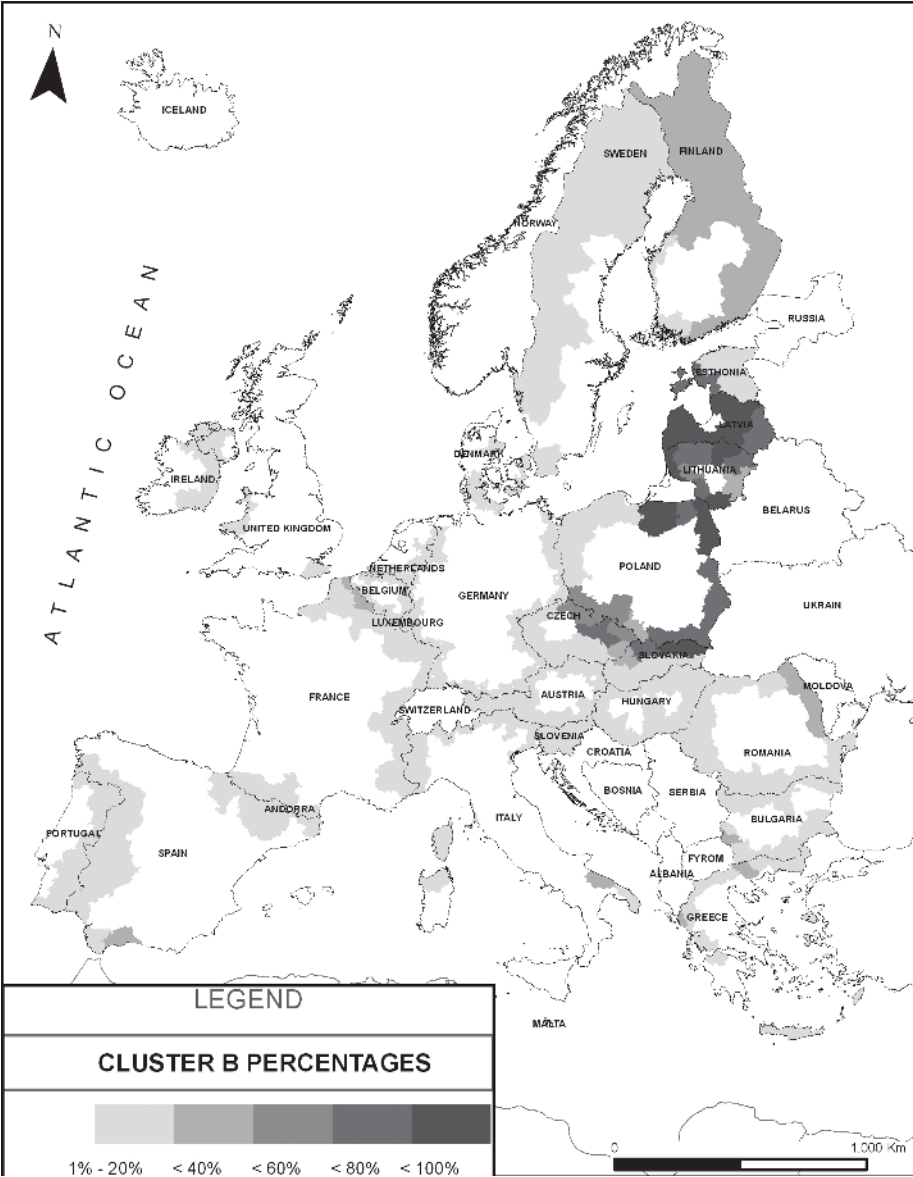
Fuzzy clustering, based on the previously created hyper-variables, allocates each EU border region among five clusters. The derived clusters are depicted in Figures 2 to 6. As the legends of the maps indicate, the darkest colors are associated with a highest participation of the region in the cluster.

Figure 2. Cluster A



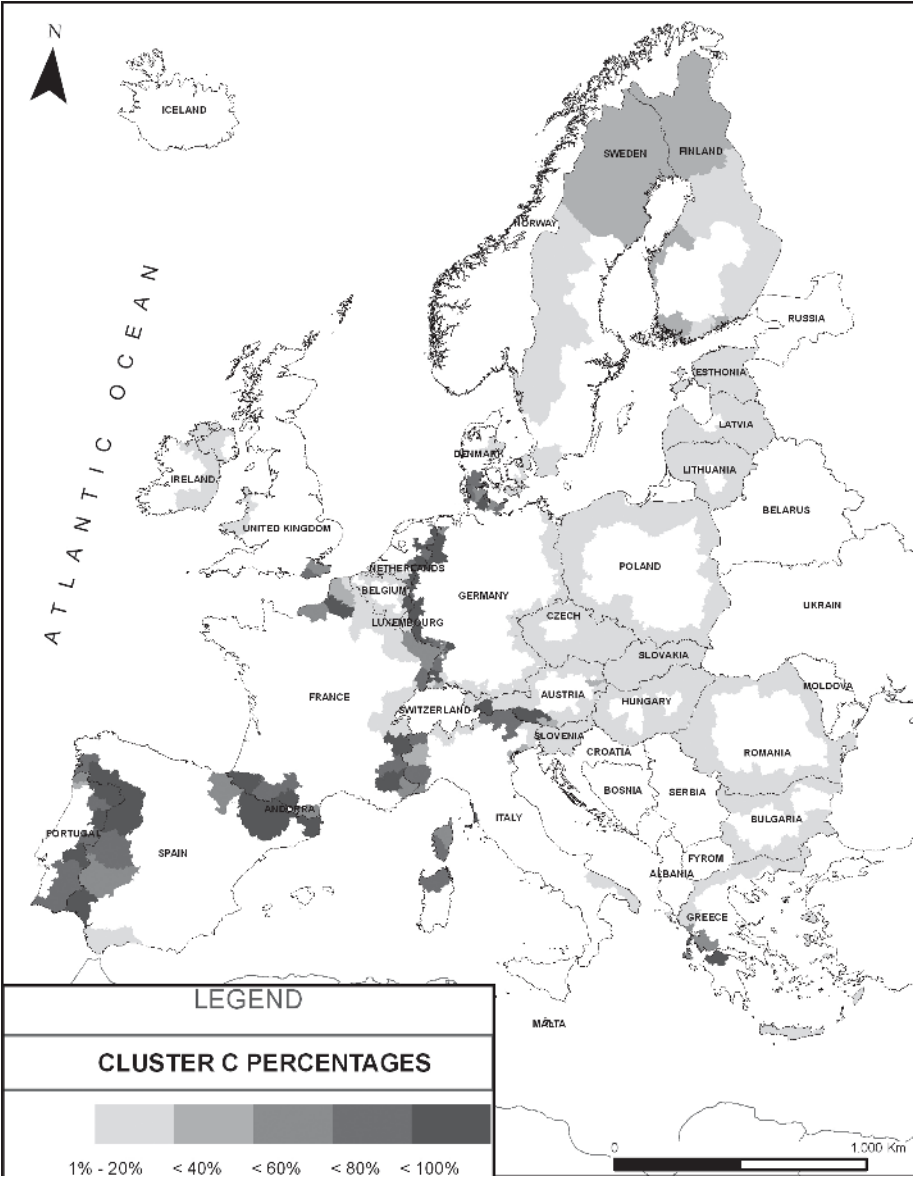
Source: Authors' elaboration

Figure 3. Cluster B



Source: Authors' elaboration

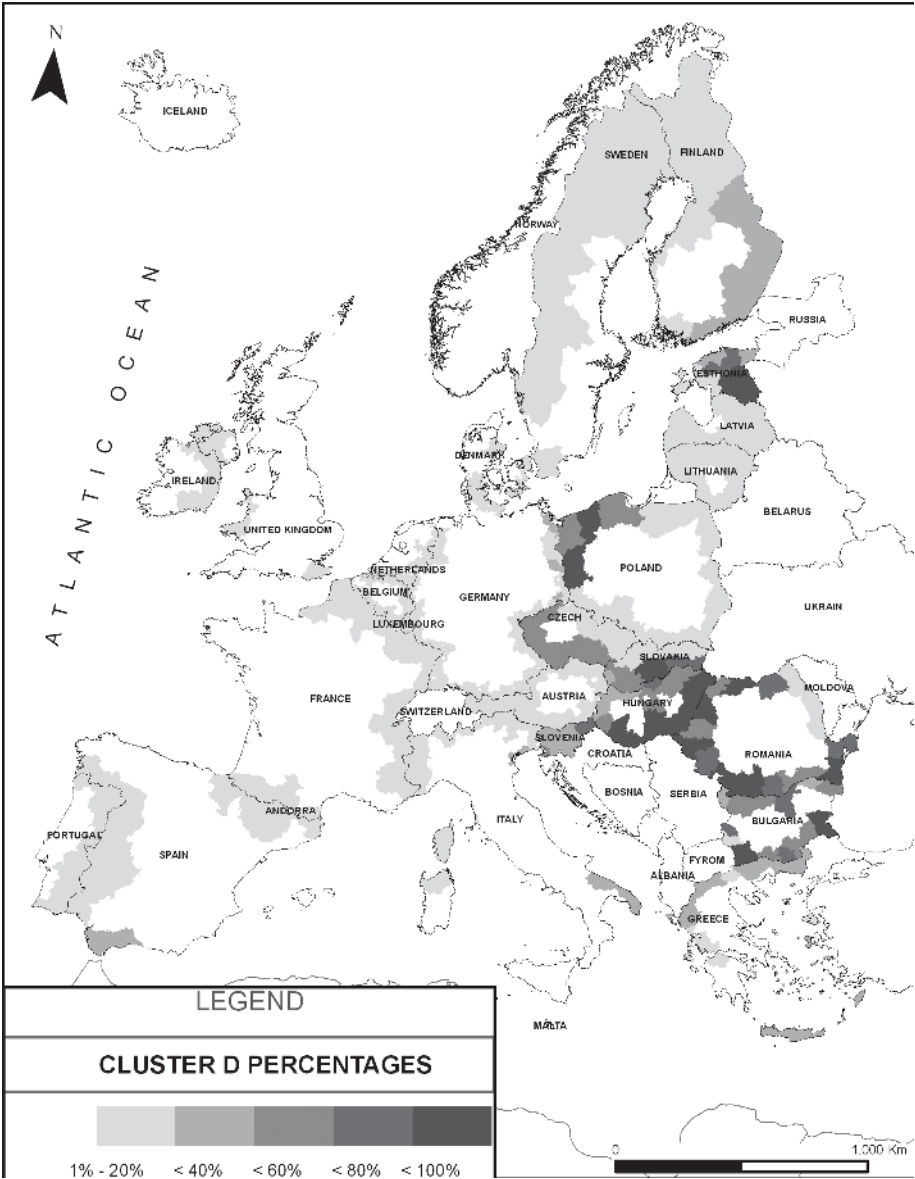
Figure 4. Cluster C



Source: Authors' elaboration

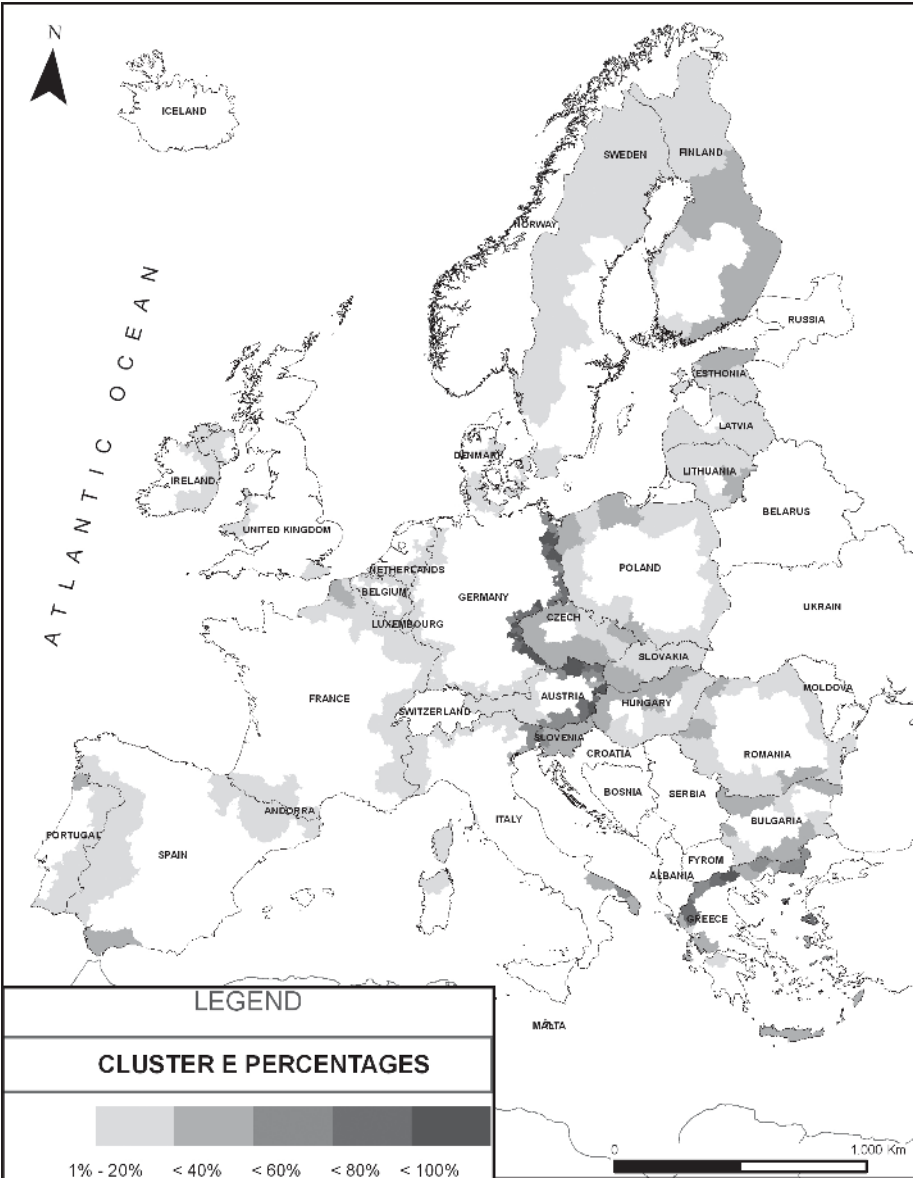


Figure 5. Cluster D



Source: Authors' elaboration

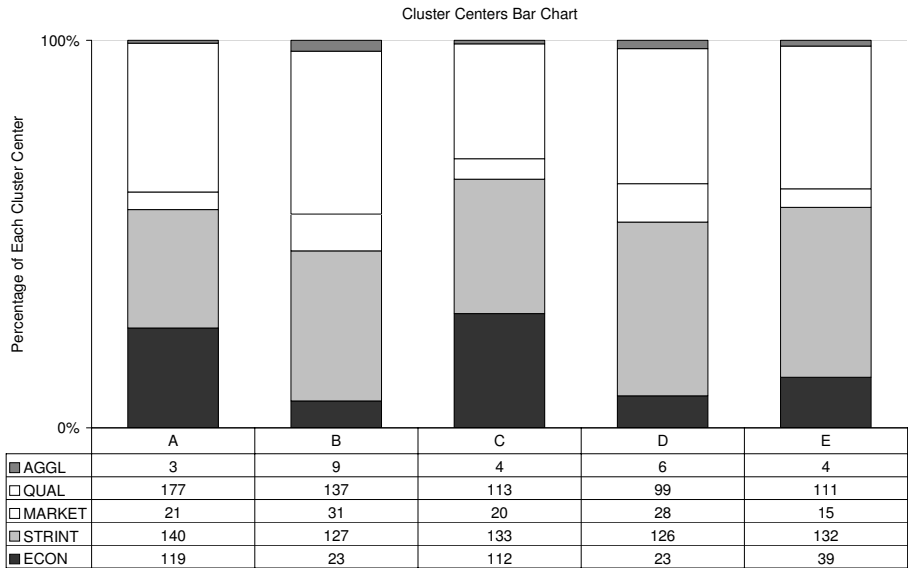
Figure 6. Cluster E



Source: Authors' elaboration

For the interpretation of the results and the description of the emerged clusters, a bar chart, presented in Figure 7, was created, illustrating the percentage composition of each cluster. Clusters are represented on the horizontal axis and the percentage values of the cluster centers on the vertical (the calculated values for each hyper-variable used are also provided in the table attached). In this way, the cluster centers percentages were compared for their contribution to the total cluster so each cluster derived has each own composition of characteristics (hyper variables values).

Figure 7. Percentage Composition of the Cluster Centers



Source: Authors' elaboration

### Presentation of the Border Regions Typology

Cluster A: This cluster includes border regions with maximum values of ECON, STRINT and QUAL and minimum values of AGGL. Despite the low concentration of economic activities, these regions were considered to be the most privileged. They combine most of the advantages of strong economic relations and common linguistic and cultural characteristics. These are the border regions located mainly in the EU15 core, in Scandinavia, in Ireland and the United Kingdom. Located in highly integrated areas, in both economic and social terms, these regions achieve high levels of economic standards.

Cluster B: This cluster includes border regions with maximum values of AGGL and minimum values of ECON and STRINT. These border regions enjoyed agglomeration economies with dynamism and potential in a context of closed borders. The abolition of borders with EU15, however, has a negative impact on their economic performance mainly due to their unfavorable geographical position. Having to deal with the increased competition, these regions present an evident need for structural adjustments. Such regions are located mainly in the Baltics, Poland, Slovakia and the Czech Republic. As long as the dynamics that support the pre-integration location pattern of activities continue to resist, these border regions are going to present the most contradicting characteristics.

Cluster C: This cluster represents border regions with maximum values of ECON and minimum values of AGGL. These are border regions that achieved high levels of economic development, despite their low ability to attract economic activities. Located in the highly integrated area of the EU15, relatively close to the EU15 core, they benefited greatly from their intensive and long-lasting economic interaction. In economic terms, this cluster is quite similar to Cluster A. However, there is a difference regarding

the qualitative parameters; this cluster the cultural and linguistic differences are perceived as negative factors (problems) to cross-border interaction. These regions are located mainly in the borderlines between France and Germany, France and Spain, France and Italy and Italy and Austria.

Cluster D: This cluster includes border regions with maximum values of MARKET and minimum values of ECON, STRINT and QUAL. These border regions have high potential for development since their spatial position in conjunction with their high population offers great opportunities and challenges. The current economic level of these regions, however, is not high due to their performance in the previous years and due to their low level of interaction caused partly by their cultural differences. These border regions are located in the western borders of the EU new member-states and in the borderlines of Romania with Bulgaria and Hungary.

Cluster E: This cluster includes border regions with minimum values of MARKET. This is the most disadvantaged cluster since it has no prevailing characteristics. The border regions being in this cluster are in a stressful position with low prospects of economic development. These regions are located in the eastern borders of the EU15, in Germany and Austria in particular, having been the external borders of the EU prior to its enlargement.

From the presentation and interpretation of the fuzzy cluster analysis results it is possible to assess the dominant cluster result for each border region i.e. the cluster to which each border region mainly belongs. The dominant cluster results for the EU border regions are presented in Figure 8, which is synthesis of the Figures 1-5.

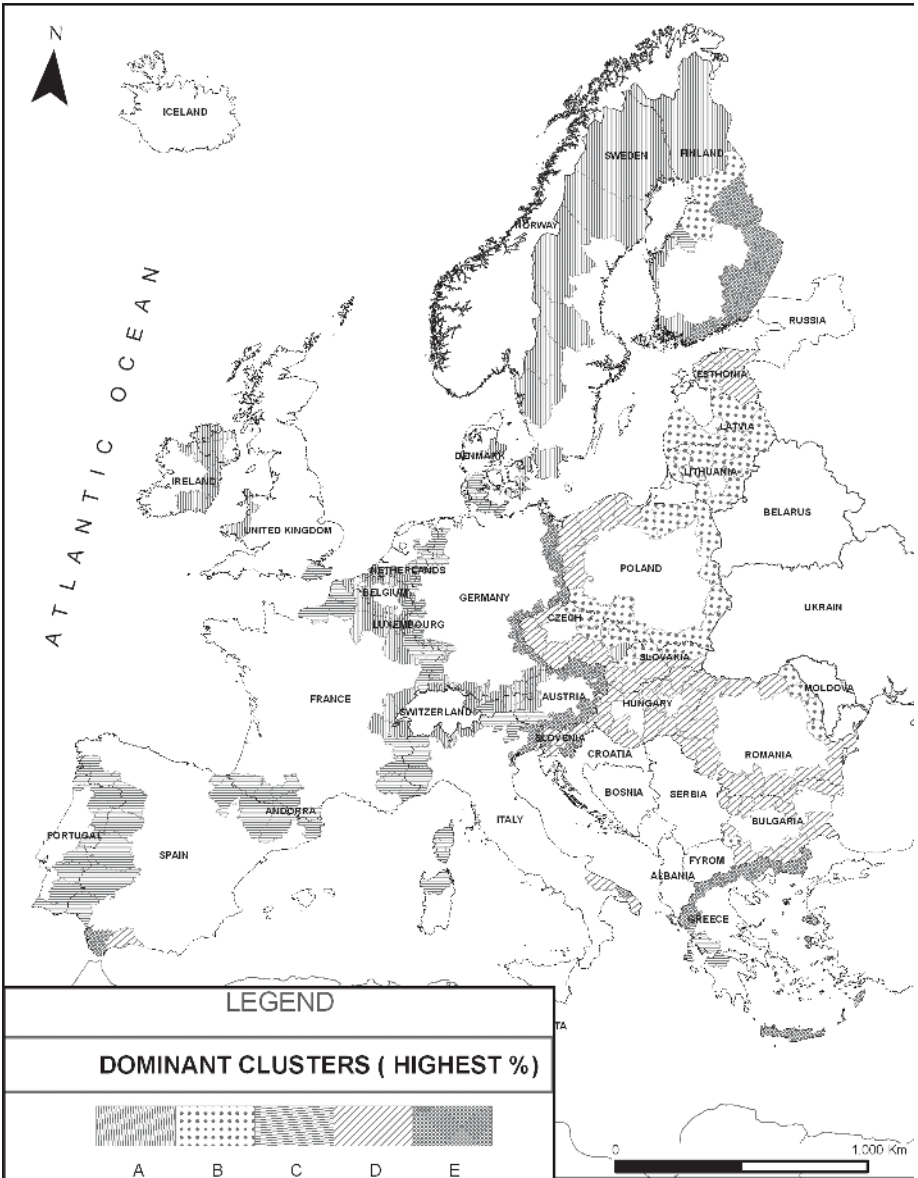
This synthesis would have been the result, if the traditional cluster analysis had been implemented from the beginning. However, the details regarding the degree of embedment of each border region to each cluster would have remained unknown.

The resulting border regions typology after the application of the factor and the fuzzy clustering analysis techniques is presented concisely in Table 5.

| Table 5                                 |  |  |
|---|--|--|
| The EU NUTS III Border Regions Typology |  |  |
| Cluster                                 | Characteristics  | Examples   |
| A                                       | Highly integrated border regions with advanced economic performance, many cultural similarities and small size.                                | Border regions in the EU15 core, Scandinavia, Ireland, UK          |
| B                                       | Border regions that enjoy agglomeration economies but need significant structural adjustments in order to deal with the increased competition. | Border regions in the Baltics, Slovakia, Czech Rep., Poland        |
| C                                       | Highly integrated border regions that present significant economic performance, though much cultural dissimilarity.                            | Border regions in France, Germany, Spain, Portugal, Italy, Austria |
| D                                       | Border regions with high development potential due to their favorable geographic position, but with low economic performance.                  | Border regions in the western side of the EU new member-states     |
| E                                       | Border regions with low market potential and no prevailing positive characteristics  | Border regions in the EU external borders prior to enlargement     |

Source: Authors' elaboration

Figure 8. Dominant Clusters Results



Source: Authors' elaboration

## Conclusions

The paper proposes a typology of border regions that reveals the socioeconomic impact of the EU integration process on the EU NUTS III border regions. The emergence of a new economic geography of border regions in the enlarged EU is associated with a set of new divides and contradictions in the European space. Borders are “melt-ing” in the EU internal space and “freezing” in the external one, drastically affecting

the development prospects of border regions. Moreover, a new “mentality map” seems to be surfacing, dealing with different perceptions and identities across the borderlines. Thus, the interpretation of the spatial dynamics occurring at the enlarged EU border regions has to take into account both economic and non-economic parameters.

The proposed typology is based on statistical techniques of factor and fuzzy cluster analysis. Factor analysis produces five (5) hyper-variables to explain the dynamics affecting the EU border regions under the EU integration process. The level of economic integration, the economic characteristics, market size, market potential and cultural conditions along the borderlines are, by and large, the most important hyper-variables. Fuzzy cluster analysis produces five (5) clusters of border regions. Each border region is attributed to each cluster according to the characteristics it presents in terms of the hyper-variables. Each cluster has its unique characteristics allowing, thus, the production and the presentation of the border regions typology for the EU NUTS III border regions.

The border regions typology depicts the different spatial patterns developed in the enlarged EU space. It seems that the politico-economic division between Western and Eastern Europe (Iron Curtain) has been replaced by new socio-economic divides that exist not only between East and West (Golden Curtain) but also inside the East and inside the West. According to the outcomes of the relative studies, inside each part (western and eastern) of the enlarged EU there is a “core-periphery” economic divide. These divides across borders mainly have to do with the geographic location of each region respective to the EU core. The divides are aggravated, in many cases, by different cultures and perceptions that exist along the borders themselves. These differences are affected, in their turn by the existing economic divides (it is very difficult to find the cause and the effect in such relationships), creating a perpetual socioeconomic cycle.

The typology shows that the EU border regions constitute a highly heterogeneous group of regions. Border regions located in the EU core (Cluster A) seem to be the most advantaged regions presenting high levels of economic performance and potential. High economic potential is also presented in the border regions located mainly in the western part of the EU new member-states (Cluster D). These regions, however, still present low levels of economic performance. Border regions located between the western EU external borders and the EU core (Cluster C) seem to be at a modest level regarding their economic performance and potential. Border regions located in the new eastern external borders of the EU (Cluster B) seem to have little potential for preserving their economic performance whereas border regions located on the eastern external borders of the EU prior to enlargement (Cluster E) seem to remain in a situation of economic isolation.

The border regions typology reveals, moreover, that border regions are, indeed, in a state of flux since the level of their economic performance differs from the respective level of their economic potential. Border regions located in the EU core (Cluster A) and in the western side of the EU new member-states (Cluster D) are probably going to benefit from the EU integration dynamics, and will improve their economic performance. Conversely, border regions located on the eastern EU external borders prior to and after the enlargement (Clusters B and E, respectively) will be faced with the pressures of EU integration, and consequently have more serious difficulties in maintaining their economic performance.

Our findings indicate that the process of integration in Europe is still associated with significant differentiation in the border zones. As a result, higher levels of integra-



tion may not be leading automatically to greater homogeneity with respect to borders. Serious heterogeneity in development prospects is a reminder of the importance of initial conditions and geography in shaping economic outcomes and also an indication of the limited ability of market forces to promote spatial cohesion.

The impact of integration on border regions will depend, to a large extent, on the balance (but also the synergies) between policy interventions and market dynamics. Although current prospects with respect to a more active EU policy agenda a more generous budget are weak, a careful inspection of prevailing conditions indicates that it will take a lot more than opening borders in order to achieve spatial convergence in Europe.

## Endnotes

<sup>1</sup> The Nomenclature of Territorial Units for Statistics (NUTS) was established by Eurostat in order to provide a single uniform breakdown of territorial units for the production of regional statistics for the EU. NUTS III regions represent the spatial level that corresponds to the administrative unit of prefectures.

<sup>2</sup> The EXLINEA project is supported by the European Commission under the Fifth Framework Programme ([www.exlinea.org](http://www.exlinea.org)).

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