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Economic Regions Based on the Agglomeration Economics: an Evaluation for the Spanish Case.

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Internal homogeneity and also heterogeneity between the regions are both desirable properties for a better understanding of the local labor markets and for increasing the efficiency of any industrial policy applied at local level. However, studies of the labor markets that include a spatial dimension are commonly limited to administrative rather than appropriately-defined functional regions. Using micro data from the latest Census available, the Spanish territory can be divided into functional regions that emphasize the importance of location and agglomeration economies (size). The objective of this paper is to prove that, when studying labor economic issues, such classification based on economic criteria results on more convenient regions than the administrative ones commonly used (NUTS regions). Based on this simple idea, the results from this study suggest that, subject to the availability of data, this alternative spatial division should be considered when carrying out labor economics studies at a sub-national level.

Keywords: regions, urban and regional economy; cluster validation, local employment and Spain.

JEL Classification: R23 and R12.

1. Introduction.

Economic data is usually spatially disaggregated according to the administrative or normative division of the territory. Unless having access to the original micro databases, it implies that any spatial analysis will be limited to the use of those administrative regions. However, such regions do not necessarily make economic sense as they are or were constructed in terms of some sort of political, administrative or historical criteria.

Using normative regions is the common practise, but in many cases statistical inference based on this division may be strongly affected by aggregation problems such as the ecological fallacy (Robinson, 1959)[1] or the modifiable areal unit problem (Openshaw 1984)[2]. In other words, the area or region created is not necessarily homogeneous, which is also referred to as aggregation bias in the literature[3].

Overall, instead of considering alternative spatial divisions, regional scientists have been devoted to formulating statistical models or estimation procedures to reduce the aggregation bias[4]. If having access to micro databases, researchers can carry out their own regionalization procedure in order to create analytical or functional areas that are conveniently related to the phenomena under examination optimizing a particular aggregation criterion[5].

In case of dealing with labour market issues, internal homogeneity and also heterogeneity between the regions created would be both desirable properties for a better understanding of the local labor markets (Fischer, 1980) as well as for increasing the efficiency of any industrial policy applied at local level (Coombes et al. 1986). Nonetheless, the existence of agglomeration economies should not either be forgotten. As well as they determine location decisions and specialization patterns for companies, they should also explain the same for workers.

The purpose of this study is not carry out a regionalization exercise to generate internally homogeneous or well differentiated labour markets according to one or several variables, but to prove that a functional classification based on the existence of agglomeration economies and the importance of location results on more convenient

[1] EF was first introduced by Robinson (1950) and has been studied by many other authors since then. See, for example, Richardson *et al.* (1987), Piantadosi *et al*. (1988), Greenland and Morganstern (1989) and Richardson (1992).
[2] See also Openshaw and Taylor (1981) and Arbia (1989).
[3] See Fotheringham and Wong (1991), Amrhein and Flowerdew (1992), Paelink and Klaassen (1979) or Paelink (2000).
[4] Gotway and Young (2002) provide a detailed overview of several statistical solutions that have been proposed to deal with this problem.
[5] See Duque et al. (2007) for a review of supervised regionalization methods.

regions for the study of labour markets issues than the administrative ones commonly used (NUTS regions). Evenmore, this economic criterion not only creates compact and well differentiated labour markets, but also allows the segmentation of the whole territory[6].

The rest of the paper is organized as follows: in the next section we discuss the meaning of *regions* and describe the aggregation criteria used for creating regions with economic sense based on agglomeration economies and the importance of location. Applied to the Spanish case using data for the latest Census available, Section 3 deals with the evaluation of these functional regions *versus* the administrative ones commonly used for studying the spatial dimension of the labour markets. Internal homogeneity within the regions and heterogeneity between them when dealing with the distribution patterns of employment are evaluated by gender, industry and level of qualification. In the light of the results of such evaluation, in the last section we summarize the main conclusions of this study.

2. Surpassing the administrative regions: an analytical proposal for the analysis of the labour markets.

What is region? From an economic point of view, a *region* is a unit in which capital and labour move freely and goods and services are totally open to trade with other regions without any frontiers or limitations[7]. The openness and the interaction with other regions are their main characteristics.

From this basic idea, a particular territory can be divided into parts or regions using different criteria. However, three elements must be taken into account (Behrens and Thisse, 2007). First, a *Region* is part of a set in which each comprising element has some specificities which make it different from the rest. Secondly, a set of regions always involves a partition of some geographical space that contains a large number of places, with a place serving as the elementary spatial unit that we use. Thirdly, a well-known result in set theory is that there is one-to-one correspondence between the family

[6] To date, in Spain no exercise to identify well defined functional regions to study labour market issues has been carried out. There are either studies focused on exclusively one administrative region (Comunidad Valenciana in Casado-Diaz, 2000) or studies at national level dealing only with the metropolitan areas (Boix and Veneri, 2009).

[7] See Polèse (2010) for a discussion.

of partitions in a set and the family of equivalence relations of the same set[8]. Based on these three basic criteria, many possible sets of regions may be defined, and as a result, depending on the point of view selected, many types of concepts of *region* can be constructed.

In labour economics, data constraints have led to a situation where any research dealing with the regional or spatial dimension of the labour markets is usually based on administrative regions such as NUTS regions in the European case[9]. Some attempts have been made to use another spatial aggregation of the data reflecting functional relationships between workers and jobs. In those cases, the basic principle for setting the boundaries of the local labour markets (LLMs) is demand-side and supply-side self-containment, which in practical terms means maximizing (minimizing) commuting flows within (between) them[10]. The regionalization procedure commonly used consists on a multi-stage aggregation process based on an algorithm originally developed by Coombes et al (1986), and since then applied to many countries, including Great Britain (where the Department of Employment defines the so-called Travel-To-Work-Areas or TTWAs), Italy (Sforzi *et al*., 1997), for Spain (Casado-Diaz, 2000; due to the lack of data local labor markets for only one *comunidad autonoma* are computed), New Zealand (Papps and Newell, 2002), Denmark (Andersen, 2002) and Australia (Watts, 2003).

However, from a pure Regional and Urban Economics perspective (see Fujita *et al*. 1999), when defining a *region* a small number of attributes should be highlighted, namely: (i) location matters, because industries (and therefore economic activity and employment) are always drawn to places best suited for commerce and interaction with markets; and (ii) size matters, because dynamic industries, or the most advanced in each epoch, are naturally drawn to large cities and places within easy reach. A corollary

[8] An equivalence relation in a set is a (i) reflexive, (ii) symmetric and (iii) transitive relation: these imply that (i) an object is always similar to itself; (ii) if one object is similar to another the latter is similar to the former and (iii) two objects similar to a third one are themselves similar.

[9] Nomenclature des Unites Territoriales Statistiques (NUTS) is the geographical system established by the Eurostat for the production of regional statistics within the European Union. According to Eurostat, these "normative regions are the expression of a political will; their limits are fixed according to the task allocated to the territorial communities, to the sizes of population necessary to carry out these task efficiently and economically, or according to historical, cultural and other factors" (Eurostat, 2006).

[10] In practice, that means setting a threshold of residents working in the area and workers living in the area (from 75% to 70% depending on population size) and also a minimum number or working population (commonly 3,500). See Ball (1980) and Coombes and Openshaw (1982) for more details about LLMs definition.

could be deduced from (i) and (ii), namely (iii) proximity to size also matters[11]. The existence of agglomeration economies (size) and the location are the key factors of this definition.

Taking these ideas into consideration, Coffey and Polèse (1988), Polèse and Champagne (1999) and Shearmur and Polèse (2004) suggest a functional classification which, though originally thought for explaining the location of economic activity and economic growth, could also be very useful for labour market analysis. As well as agglomeration economies and location determine location decisions and specialization patterns for companies, they should explain the same for workers (employment). In practical terms, with the functional classification the spatial statistical units (either census divisions, counties, municipalities, länders, etc) that constitute the national economic space are aggregated based on the population size and distance to the metropolis.

Figure 1 represents this idealized national space economy with one big metropolis at the centre, four smaller "central" urban areas of different population sizes around it, as well as other "central" rural areas (these areas, either urban or rural, are close to the metropolis)[12]. Another four analogous size classes represent the "peripheral" urban areas, which are located at some distance from the metropolis and surrounded by their corresponding rural areas.

HERE FIGURE 1

Following this classification, size and distance criteria to the metropolis determines five types of areas: *Metropolitan Areas,* areas of more than five hundred thousand inhabitants that include the city and its surrounding area of influence. They are *ad hoc* specifications; *Urban Areas,* urban areas with more than ten thousand inhabitants that are at less (*central urban areas*) or more (*peripheral rural areas*) than one hours' drive from the metropolitan area[13]; and *Rural Areas,* areas with less than ten thousand

[11] Another basic idea of regional economics is that (iv) cost matters, because without adequate size or a propitious location, places will grow if they have a clear labour cost advantage or, alternatively, an exceptional resource endowment (Polèse, 2010).

[12] The reader will undoubtedly note the resemblance with the classic idealized economic landscapes of Christaller, Lösch, and Von Thünen, all of which posit one metropolis or marketplace at the centre, see Polèse y Rubiera (2009) for widely discussion.

[13] The one hour's drive criterion takes into account several factors such as road conditions (e.g., highway or not), the spatial limits of metropolitan areas, and the distinctive characteristics of the area being classified.

inhabitants that are close (*central rural areas*) or away *(peripheral rural areas*) from the metropolitan areas[14].

Applied to the Spanish territory in Polèse *et al*. (2007) to explain the location of economic activity and in Viñuela *et al.* (2010) to explain employability patterns, in reality this classification based on economic criteria results on a picture quite similar to Figure 1, but with two big metropolitan areas (Map 1).

HERE MAP 1

According to the most recent Census available (INE, 2007), in 2001 there were 8,106 municipalities in Spain. Madrid and Barcelona metropolitan areas concentrate 22.56% of the total population but only include 4.8% of the municipalities (or 394 out of the 8,106). Some of the municipalities are extremely small[15]. The municipalities with less than 50,000 inhabitants, either included into the *central* or *peripheral* rural areas categories, despite concentrating only 7.1% and 11.8% of the total population, they represent 20.9% and 65.6% of the total Spanish municipalities respectively (see Appendix I for more details).

Administratively, Spain is divided into seventeen *Autonomous Communities (*NUTS II regions*)*, some of which include several provinces (NUTS III) for a national total number of 50 provinces[16]. Each province is in turn divided into several municipalities, ranging from 34 (Las Palmas) to 371 (Burgos). Furthermore, the seventeen *Autonomous Communities* are also aggregated into seven administrative regions (NUTS I regions), which have no real internal meaning and are only used for comparative purposes with some other European member-states. The Spanish Census offers detailed information about 5% of the population. One of the variables included is the municipality of residence of the individuals, which makes possible aggregating the micro data into the eight types of analytical regions.

Although this paper does not deal directly with the labour economics literature on local labour markets, i.e., the analytical areas were not constructed using any sort of commuting criteria, it can be easily proved that the travel-to-work commuting patterns

[14] Given the characteristics of the Spanish cities, according to size two categories of metropolitan areas (above or below 500,000 inhabitants) and urban areas (above or below 100,000 inhabitants) are created. See Polèse *et al.* (2007) and Polèse and Rubiera (2009) for more details about the classification applied to Spain.

[15] In 2001 there were two municipalities - Salcedillo (Teruel) and Illán de Vacas (Toledo)- with only 7 inhabitants. Almost 12% of the municipalities have less than 100 inhabitants. The figure increases to 26% for less than 200 inhabitants.

[16] Ceuta and Melilla are excluded from the study.

of these functional regions generated under the size and proximity criteria also fit into the definition of a local labour market area. This is an additional positive feature of the analytical regions as it is agreed that the LLMAs are the ideal geographical areas for the implementation of any regional industrial policy or for reporting disaggregated labour figures (Ball, 1980).

Table 1 shows commuting patterns for the eight types of regions under analysis. The metropolitan areas and the regions that include the bigger municipalities (cities with more than 100,000 inhabitants and their surrounding areas or influence)[17] would also strictly fulfil the 75% threshold for commuting patterns set in the labour economics literature, i.e., they are self-contained local labour markets -or travel-to-work areas- from both the demand and the supply side.

HERE TABLE 1

Besides the accomplishment of the commuting criteria, in theory an optimal region should fulfill at least one of two principles (Fischer, 1980): *internal homogeneity*, whereby individual regions should be as homogeneous in the attribute space as possible, and *external separation*, whereby different regions should be as far apart in the attribute space as possible. Pursuing both principles, on the next section we will evaluate the robustness of the functional regions suggested versus the administrative ones commonly used (NUTs at different levels) for the study of the Spanish labour markets.

3. Evaluation of the analytical classification.

3.1. Evaluation criteria.

Although no statistical algorithm or method has been used for the definition of the analytical regions, when evaluating them versus the traditional administrative division, same criteria proposed for clustering evaluation and selection of an optimal clustering scheme applies: (i) *Compactness*, i.e., the members of each region should be as close as each other as possible; and (ii) *Separation*, i.e., the regions themselves should be widely spaced[18].

[17] As suggested by Papps et al. (2002), "The metropolitan area system is not designed to deal with rural areas" (p. 6).

[18] There are different approaches to measuring the distance between two regions: distance between the closest members of the regions (single linkage), between the most distant members (complete-linkage) or between the centers of the clusters (comparisons of centroids). See Berry and Linoff (1996).

Applied to local labour markets, the first criteria (internal homogeneity) imply the existence of very well defined labour markets where the municipalities included share common characteristics, problems and diagnosis. This compactness is a desirable feature for any active labour policy designed to be implemented at local level. As for the second criteria (dissimilarity between regions), the existence of differences between regions in practical terms implies the spatial customization of policies, i.e., policymakers should be very aware of the economic characteristics of each region in order to try to identify its particular problems. In other words, the success of a policy in a certain region does not guarantee its immediate success in another.

3.2. Hypotheses.

To evaluate the relative performance of the analytical ones designed under economic criteria versus the traditional administrative regions (NUTS I, NUTS II and NUTS III regions), we will test the following hypothesis:

H1: given the existence of agglomeration economies and the importance of location, the analytical regions are better for describing the *employment* distribution patterns, either *total or by gender*, in the Spanish territory than any of the administrative divisions.

H2: the analytical regions capture the patterns of distribution of *employment by industry* better than the administrative regions commonly used.

H3: the spatial distribution of *employment by type of job performed and level of qualification* can be better explained on bases of the analytical regions than any of the administrative divisions commonly used.

3.3. Evaluation indexes: Theil inequality index and Davies-Bouldin Validity Index.

To test the three hypothesis we will use the well-known Theil inequality index (Theil 1967), commonly applied to the distribution of income and wealth. The index can be decomposed as the sum of the *between* and a *within* component[19]. Its *within* component will be useful to quantify the intraregional homogeneity of the regions when dealing with the spatial distribution of employment. Given the characteristics of Theil's index, if the internal homogeneity of the regions increases (a decrease of the within component), that necessarily implies that the heterogeneity between regions increases (a rise of the *between* component). Nowadays, in reality this is not necessarily the case; a given

[19] For more details about the calculation of the Theil index, see Appendix II.

region may be very well defined internally but exhibit no particular differences from another (the reverse also applies).

In order to include both criteria simultaneously –*compactness* and *separation*-, we have to use techniques specifically designed for clustering validation. Thus, it seems necessary to test also the three hypotheses with the Davies-Bouldin Validity Index (Davies and Bouldin, 1979)[20]. Given the characteristics of our database and the administrative and analytical classifications of the regions (non-hierarchical crisp clusters with different numbers of regions), the Davis-Bouldin index is the most appropriate clustering validation technique as it exhibits no trends with respect to the number of regions[21]. This index estimates the average similarity between each region and the most similar one to it, so small values of the index are indicative of the presence of compact and *also* well-separated regions.

3.4. Evaluation results.

The first hypothesis under scrutiny is related to the use of the functional regions or the administrative ones for the study of the spatial distribution of employment and the distribution of employment by gender.

Table 2 shows the within component of the Theil's index and the Davis-Bouldin index (total and by gender) when the 8,106 Spanish municipalities are aggregated into administrative regions –NUTS I (7 regions), NUTS I (17 *Comunidades Autónomas)*, NUTS III (50 *Provinces)*- and into the analytical regions suggested (8 regions).

HERE TABLE 2

Despite of the scale effect, i.e., everything else equal, intraregional inequality drops with the number of regions, the *within* component for the eight analytical regions is clearly lower than for any of the NUTS regions. In other words, the classification proposed shows a higher degree of internal homogeneity in the distribution of employment so that the local labor markets generated under the size and distance criteria are more integrated or coherent (even by gender) than any other political-administrative division of the territory.

The Davies-Bouldin index also shows better results (lower value of the index) for the analytical regions than for any other type of normative division. Surprisingly enough,

[20] For more details about the calculation of the Davies-Bouldin index, see Appendix III.

[21] For a good review of the main clustering validation techniques, see Halkidi et al, 2001).

when taking into account internal homogeneity and also heterogeneity between regions (the main advantage of the DB index), NUTS I regions show better results than the NUTS II or NUTS III regions. This proves that despite being made up of *Comunidades Autonomas* with a higher degree of internal heterogeneity, the NUTS I division "artificially created" for comparison purposes within the European Union at least manages to divide the Spanish territory into seven large areas which are clearly differentiated and pretty homogeneous: North-West, East, North-East, Madrid, Centre, South and Canary Islands. In any case, however, the results for the eight analytical regions are better.

As expected, we can talk about one labor market for men and another one for women. These are two different labor markets –also at regional level-, that show a higher level of homogeneity – and heterogeneity between them - when studied separately.

The second hypothesis under scrutiny is related to the spatial patterns of distribution of employment by industry. The 2001 Spanish Census offers employment figures for sixteen (16) types of industries[22]. Results for the Theil index (total and decomposed) and the Davis-Bouldin index according to the industrial classification used in the Census (Table 3) show a higher internal homogeneity within and also heterogeneity between the analytical regions for all industries except "Agriculture, hunting and forestry activities and fishing" and "Extractive Industries". One simple explanation is that these particular activities are necessarily linked to the physical location of the natural resources at hand - land, forests, rivers or mines- and therefore the chances to *choose* the geographical location of employment or for employment to move *freely* are very limited. In other words, the distribution of these activities does not depend on agglomeration economies but on the location of the natural resources.

HERE TABLE 3

For testing the third hypothesis, i.e., the analytical regions are a better option -more compact and differentiated-, when dealing with spatial analysis of labor markets by different levels of qualification, the classification available at the 2001 Census describes 9 groups aggregated by type of work and level of qualification. In this special classification, qualification is understood as the capacity to carry out the tasks which comprise any given job. Therefore, it includes two different facets: level of qualification and specialization within this level qualification. In order to work with a more standard

[22] "Agriculture, Hunting and Forestry Activities" and "Fishing" have been aggregated, therefore results only show 15 types of industries.

classification, we aggregate those 9 groups into "High-Qualified Occupations", "Medium-Qualified Occupations" and "Low-Qualified Occupations"[23]. The results of the Theil and Davis-Bouldin index by level of qualification are shown in the following table (Table 4)[24].

HERE TABLE 4

For all levels of qualification, the within component is clearly lower than any other administrative division. The differences are slightly more pronounced for the high qualified jobs, where agglomeration economies might play a more effective role.

For the third hypothesis tested, namely the suitability of the analytical regions for the study of the spatial patterns of distribution of employment by level of qualification and occupation, the Davis-Bouldin index confirms those from the Theil index. The analytical regions are also a better option when dealing with local labor market issues by level of qualification or occupation.

4. Conclusions.

To date, analysis of the spatial dimension of Spanish labor market has been limited to administrative, rather than appropriately-defined functional, geographic units. Alternative divisions of the territory based on the existence of agglomeration economies and the importance of geography have been used in the literature to understand the location of economic activity (Polèse *et al*., 2007) or explain the employability patterns (Viñuela *et al*., 2010). However, their robustness against the administrative ones commonly used has –to date- not been evaluated. The objective of this paper is to prove those functional regions defined under such economic criterion provide better defined regions –more compactness and separation- than the administrative ones commonly used to carry out labour market studies at sub-national level.

Using micro data from the last Spanish Census available, the functional and administrative regions are evaluated using the Theil index and the Davis-Bouldin Validation index. Applied to employment (by gender, industry and level of qualification and occupation), both indexes show better results for the analytical regions than for any of the ordinary administrative ones (NUTS I, II or III regions). The analytical classification generates areas where the distribution of employment is more

[23] For details about the nine categories and their aggregation, see Appendix IV.
[24] See Appendix V for Theil's Index results for the nine categories.

homogeneous within and more heterogeneous between the regions. Agglomeration economies and distance (to the metropolis) seem to be relevant for understanding the patterns of distribution of employment, either by gender, by industry or by level of qualification and occupation. In practice this means a clearer way for identifying local labour markets and explaining their differences and similarities.

In the light of these results, this paper suggests that, subject to the availability of data, this alternative classification could be considered when carrying out labor economics studies that include a *spatial* dimension. The use of this classification can offer a better understanding of the job opportunities, location of industries, concentration of unemployment, occupations and so many other labour related topics. Surpassing the administrative division of the territory, this classification manages to have explanatory power in spatial labour economics topics while including geoeconomic characteristics as relevant as location and agglomeration economies.

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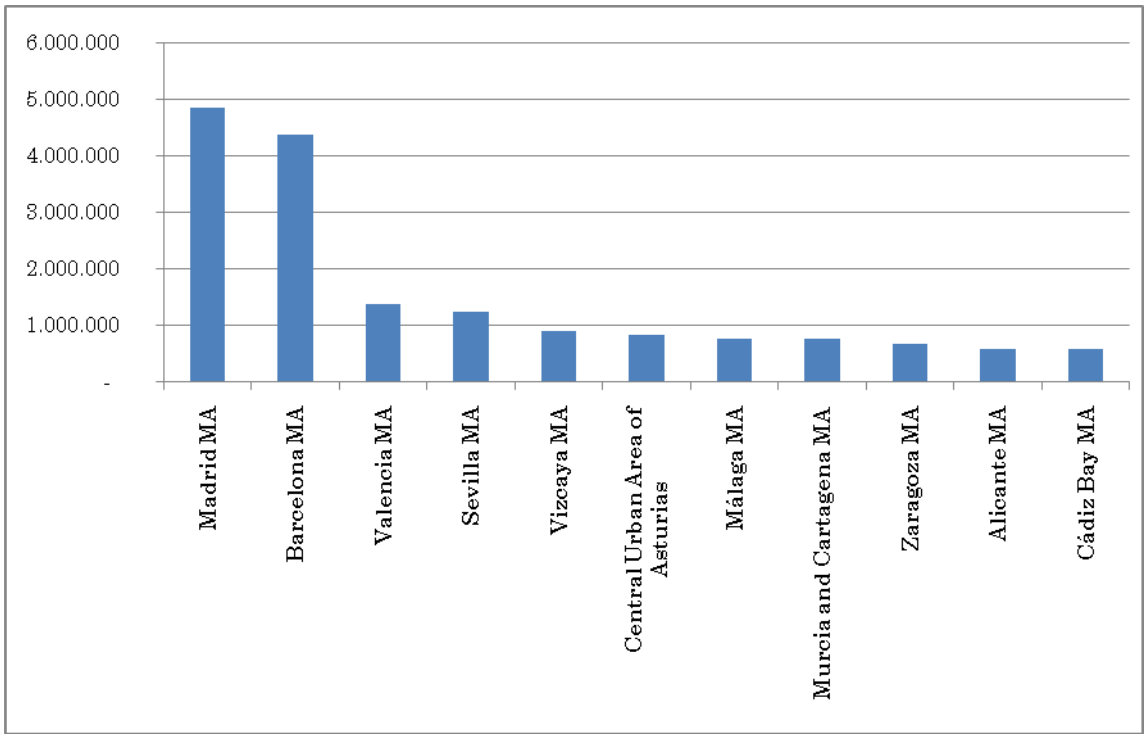
APPENDIX I: Total Population of the Spanish Metropolitan Areas and the rest of analytical regions.



Analytical Region		Total Population	Number of municipalities
MA1			
	Madrid MA	4,866,821	30
	Barcelona MA	4,372,091	162
MA2			
	Valencia MA	1,389,585	47
	Sevilla MA	1,237,066	27
	Vizcaya MA	895,086	34
	Central Urban Area of Asturias	832,843	18
	Málaga MA	776,744	15
	Murcia and Cartagena MA	766,222	14
	Zaragoza MA	679,721	28
	Alicante MA	592,230	13
	Cádiz Bay MA	577,756	6
CUA1		2,163,392	74
CUA2		3,669,212	171
CRA		3,014,919	1,694
PUA1		5,587,002	259
PUA2		3,970,633	193
PRA		5,318,132	5,321
Total		**40,709,455**	**8,106**

APPENDIX II: Decomposition of the Theil's inequality index.

Applying the Theil inequality index (Theil 1967) to employment, the formula is computed as follows:

$$T = \sum_{m=1}^{n} \frac{PopEmp_{municip}}{PopEmp_{Esp}} \log\left(\frac{PopEmp_{municip} / PopEmp_{Esp}}{1/n} \right)$$

where n is the number of municipalities considered (8,106), $PopEmp_{municip}$ is the population employed in municipality m, and $PopEmp_{Esp}$ represents the Spanish working population.

The Theil index can be completely and perfectly decomposed into a *between-group* component (Tg) and a *within-group* component (Tw). Intraregional homogeneity can be therefore quantified by the within-group component. Thus:

$T = Tg + Tw$

with

$$Tg = \sum_{r=1}^{R} \frac{PopEmp_{r}}{PopEmp_{Esp}} \log\left(\frac{PopEmp_{r} / PopEmp_{Esp}}{n_r / n} \right)$$

$$Tw = \sum_{r=1}^{R} \frac{PopEmp_{r}}{PopEmp_{Esp}} \sum_{m=1}^{n} \frac{PopEmp_{municip}}{PopEmp_{r}} \log\left(\frac{PopEmp_{municip} / PopEmp_{r}}{1/n_r} \right)$$

where r indexes regions, with n_r representing the number of municipalities in region r and $PopEmp_r$ the population employed in the region r to which the municipality belongs.

As the within component quantifies the heterogeneity between the individuals of a region, small values indicate the existence of a high degree of internal homogeneity.

APPENDIX III: The Davies-Bouldin Validation Index.

This index (Davies and Bouldin, 1979) is a function of the ratio of the sum of within-region scatter to between-region separation, and it is defined as:

$$DB_m = \frac{1}{m}\sum_{i=1}^{m} R_i$$

where $R_i = \max_{j=1,.....mj\neq i} R_{ij}, i = 1,....,m$ and m is the number of regions in which the Spanish territory is divided for each classification.

Then, the similarity index R_{ij} between region i (*Ri*) and region j (*Rj*) is defined as:

$$R_{ij} = \frac{S_i + S_j}{d_{ij}}$$

where S_i is a measure of dispersion of R_i and $d(C_i, C_j) \equiv d_{ij}$ the dissimilarity between two regions. The index R_{ij} satisfies the following:

1. $Ri\,j \geq 0$
2. $Ri\,j = Rji$
3. if $Si = 0$ and $S\,j = 0$ then $Ri\,j = 0$
4. if $S\,j > S\,k$ and $di\,j = dik$ then $Ri\,j > Rik$
5. if $S\,j = Sk$ and $di\,j < dik$ then $Ri\,j < Rik$.

The dissimilarity between region Ri and region Rj, in a l-dimensional space is defined as:

$$d_{ij} = \left\| \overline{EmpPop_i} - \overline{EmpPop_j} \right\| = \sqrt{\sum_{k=1}^{l} \left| \overline{EmpPop_{ik}} - \overline{EmpPop_{jk}} \right|^2}$$

and the dispersion of a region Ri is defined as:

$$S_i = \sqrt{\frac{1}{n_i}\sum_{x\in R_i} \left\| EmpPop - \overline{EmpPop_i} \right\|^2}$$

As DBm is the average similarity between each region and its most similar one, small values of DB are indicative of the presence of compact and well-separated regions. The DBm index exhibits no trends with respect to the number of regions.

APPENDIX IV: Type of job and level of qualification according to the 2001 Census classification and broad aggregation.

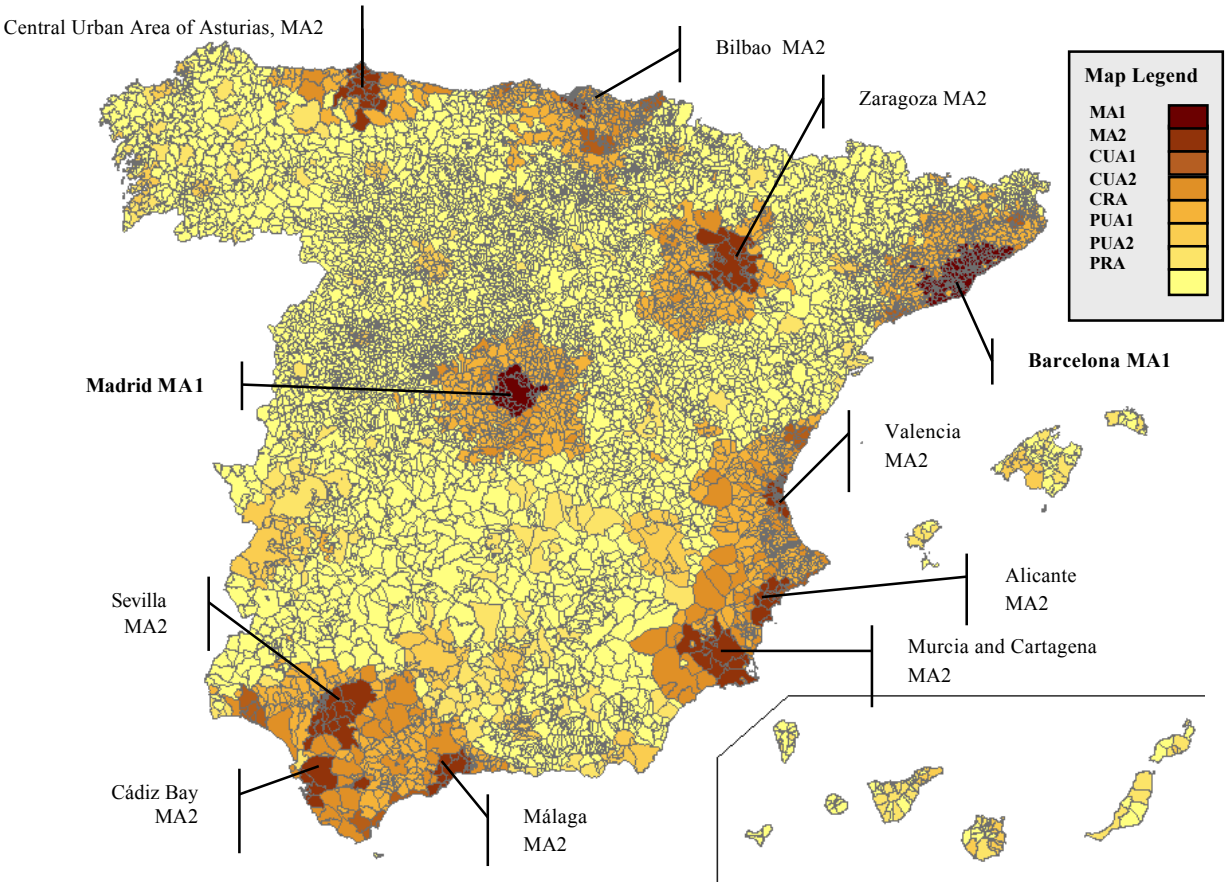
CN01 CLASSIFICATION (2001 Spanish Census)	AGGREGATION
1 -Business and public administration management/managers	Highly-skilled personnel: directors, highly-qualified professionals and skilled technical staff
2 - Technical staff and scientific and intellectual professionals	
3 - Technical and professional support staff	Medium-skilled personnel: technical staff and administrative support staff
4 - Administrative staff	
6 - Skilled workers in agriculture and fisheries	
7 - Artisans and qualified workers in manufacturing, construction and mining excluding machine operators and installation workers	
5 - Hostelry, security and retail sales workers	Low-skilled personnel: tertiary workers and industrial, artisanal and agricultural operators/laborers
8 - Machine operators, installation workers and fitters.	
9- Unskilled workers	

APPENDIX V: Decomposition of the Theil inequality index by level of qualification and occupation (9 categories).

		Administrative Regions			Analytical Regions
		NUTS III (PROV) (50 Regions)	NUTS II (CCAA) (17 Regions)	NUTS I (7 Regions)	MA1 to PRA (8 Regions)
Business and public administration management/managers					
Theil's Index	Between	1.2665	1.2534	0.4419	0.6264
2.5227	Within	1.2563	1.2693	2.0809	1.8963
Technical staff and scientific and intellectual professionals					
Theil's Index	Between	1.5881	1.5795	0.5218	0.7260
3.2942	Within	1.7060	1.7146	2.7723	2.5682
Technical and professional support staff					
Theil's Index	Between	1.5722	1.5577	0.5548	0.7867
3.0469	Within	1.4747	1.4892	2.4921	2.2602
Hostelry, security and retail sales workers					
Theil's Index	Between	1.3473	1.3360	0.4774	0.6759
2.6168	Within	1.2695	1.2808	2.1394	1.9409
Skilled workers in agriculture and fisheries					
Theil's Index	Between	0.3152	0.3113	0.2496	0.3604
1.0321	Within	0.7170	0.7209	0.7826	0.6717
Artisans and qualified workers in manufacturing, construction and mining excluding machine operators and installation workers					
Theil's Index	Between	1.1107	1.0911	0.3619	0.5742
2.0863	Within	0.9756	0.9952	1.7243	1.5121
Machine operators, installation workers and fitters					
Theil's Index	Between	1.1173	1.0859	0.3254	0.5464
2.1345	Within	1.0172	1.0487	1.8092	1.5882
Unskilled workers					
Theil's Index	Between	1.1214	1.1103	0.4990	0.6771
2.3019	Within	1.1805	1.1916	1.8028	1.6248

Source: Authors' calculations based on 2001 Spanish Census (INE, 2007).

Map 1: Spanish Territory into the Eight Analytical Types of Regions



Source: Own elaboration based on Polèse *et al.* (2007) and Viñuela *et al.* (2010).

Table 1: Commuting patterns between the Analytical Regions.

Analytical Regions	MA1	MA2	CUA1	CUA2	CRA	PUA1	PUA2	PRA
Percentage of people working in the residence region	91.2	89.5	84.3	**69.6**	**59.3**	87.7	77.7	**65.8**
Percentage of people living in the working region	88.1	84.6	75.4	**69.2**	**68.6**	76.2	79.5	83.9

Source: Authors' calculations based on 2001 Spanish Census (INE, 2007).

Table 2: Analytical versus administrative regions. Theil's index and Davis-Bouldin index (Employment, total and by gender).

		Analytical Regions	Administrative Regions		
		MA1 to PRA (8 Regions)	**NUTS III (PROV)** (50 Regions)	**NUTS II (CCAA)** (17 Regions)	**NUTS I** (7 Regions)
Theil's Index		*Within*	*Within*	*Within*	*Within*
Total	**24.33**	11.83	18.10	19.44	21.93
Male	**23.11**	11.17	17.15	18.47	20.81
Female	**26.43**	12.98	19.72	21.10	23.86
Davis-Bouldin Index					
Total		36.33	579.96	3,313.01	57.70
Male		33.22	232.58	518.72	40.33
Female		20.36	525.03	189.63	1,914.03

Source: Authors' calculations based on 2001 Spanish Census (INE. 2007)

Table 3a: Analytical versus administrative regions. Theil's index and Davis-Bouldin index (Employment by industry).

	Analytical Regions	Administrative Regions		
	MA1 to PRA (8 Regions)	**NUTS III (PROV)** (50 Regions)	**NUTS II (CCAA)** (17 Regions)	**NUTS I** (7 Regions)
Theil's Index	*Within*	*Within*	*Within*	*Within*
Agriculture. hunting and forestry activities and fishing				
12.98	0.84	0.75	0.81	0.90
Extractive Industries				
30.81	24.36	17.42	21.80	24.07
Manufacturing				
23.36	10.96	16.91	18.86	19.69
Production and Distribution of Energy				
26.99	14.68	20.60	21.95	22.68
Construction				
20.30	0.99	14.55	15.68	16.29
Minorsalers; Repairs				
25.60	12.18	19.14	20.52	21.08
Hotels and Restaurants				
25.41	13.18	17.94	19.19	19.99
Transportation, Storage and Communications				
29.78	14.77	21.41	22.98	23.56
Financial Intermediation				
34.33	17.64	25.75	27.23	27.74
Real State, Rental and Business Services				
34.33	16.87	25.12	26.88	27.44
Public Administration and Defense				
27.99	14.76	21.80	22.86	23.34
Education				
29.18	14.83	23.00	24.30	24.93
Health and Veterinary Activities				
30.35	15.35	24.26	25.64	26.19
Other social activies and servicies for households				
29.10	14.32	21.37	22.87	23.43
Household's Activities				
33.30	17.63	24.12	25.70	26.37

Table 3b: Analytical versus administrative regions. Theil's index and Davis-Bouldin index (Employment by industry).

	Analytical Regions	Administrative Regions		
	MA1 to PRA (8 Regions)	**NUTS III (PROV)** (50 Regions)	**NUTS II (CCAA)** (17 Regions)	**NUTS I** (7 Regions)
Davis-Bouldin Index				
Agriculture. hunting and forestry activities and fishing	123.23	88.29	105.12	42.08
Extractive Industries	98.12	361.34	59.34	53.41
Manufacturing	547.64	390.49	100.55	25.60
Production and Distribution of Energy	44.44	383.65	420.25	54.29
Construction	15.21	245.92	131.27	23.29
Minorsalers; Repairs	23.55	328.13	2140.30	69.43
Hotels and Restaurants	20.90	450.71	527.21	188.20
Transportation, Storage and Communications	23.47	340.48	159.81	116.33
Financial Intermediation	10.92	857.83	839.29	60.31
Real State, Rental and Business Services	9.81	375.78	107.10	33.13
Public Administration and Defense	29.09	866.40	101.17	20.18
Education	25.13	789.15	117.58	34.01
Health and Veterinary Activities	29.68	433.19	29.45	37.13
Other social activities and services for households	13.76	520.02	437.47	158.37
Household's Activities	12.67	497.93	354.12	29.10

Source: Authors' calculations based on 2001 Spanish Census (INE. 2007)

Table 4: Analytical versus administrative regions. Theil's index and Davis-Bouldin index (Employment by occupation).

		Analytical Regions	Administrative Regions		
		MA1 to PRA (5 Regions)	**NUTS III (PROV)** (50 Regions)	**NUTS II (CCAA)** (17 Regions)	**NUTS I** (7 Regions)
Theil's Index		*Within*	*Within*	*Within*	*Within*
High Qualified	**29.78**	15.25	22.96	24.36	24.90
Medium Qualified	**23.30**	11.34	17.22	18.58	19.13
Low Qualified	**23.21**	11.18	17.05	18.35	18.95
Davis-Bouldin					
High Qualified		19.55	149.06	503.67	64.94
Medium Qualified		28.18	681.13	167.34	99.87
Low Qualified		33.68	330.02	402.27	64.77

Source: Authors' calculations based on 2001 Spanish Census (INE, 2007).