

Local labour markets and mobility in Spain 2001-2011

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Abstract

The aim of this paper is to analyse the changes of Local Labour Markets (LLM) in Spain from 2001 to 2011 of 11 population subgroups (gender, 4 activities, 4 sectors and general population). An algorithmic iterative process with N-1 steps is used to examine commuting data for the 11 subgroups and to trace LLM in both years by maximising the self-containment of jobs (number of jobs occupied by residents of the area and number of residents working in the same area) of the generated areas. Four indexes are calculated for each LLM, and the variation of these four indexes between 2001 and 2011 allows us to classify them as areas that change from areas with a surplus of jobs to deficit areas, or vice versa. The evidence indicates an increase in mobility, difference in the rates of mobility according to subgroup characteristics, and the conversion of surplus markets in employment to deficit markets. These trends give way to wider functional areas and lower levels of self-containment reflected in the length of the journey to work. This impacts quality of life, social cohesion, and the sustainability of the territories.

Keywords: *Local Labour Markets, Employment, Mobility, Labour Policy, Immigrant Workers*

Rezumat. Piețele locale de forță de muncă și mobilitatea în Spania în perioada 2001 - 2011

Lucrarea își propune să analizeze modificările înregistrate pe piețele locale de forță de muncă (PLF) din Spania din 2001 până în 2011, analizând 11 subgrupe de indicatori (ținând cont de sex, 4 activități, 4 sectoare și populația totală). Pentru analiza datelor privind navetismul pentru toate cele 11 subcategorii, precum și pentru identificarea schimbărilor de PLF pentru ambii ani s-a folosit un proces iterativ algoritmic cu N-1 pași, maximizând slujbele auto-restricționate (numărul de slujbe deținute de rezidenții din zonă și numărul rezidenților ce lucrează în aceeași zonă) pentru ariile generate. Pentru fiecare PLF sunt calculați 4 indici, variația acestora între 2001 și 2011 permițându-ne să identificăm dacă trec dintr-o categorie în alta (de la areale cu un surplus de locuri de muncă la areale cu deficit sau invers). Rezultatele arată că există o creștere a mobilității, diferențe ale ratelor de mobilitate în funcție de caracteristicile subgrupurilor, precum și conversia piețelor cu surplus de locuri de muncă în piețe cu deficit. Aceste tendințe reliefează vaste zone funcționale precum și niveluri mai reduse de auto-restricționare, reflectate în timpul parcurs pentru a ajunge la locul de muncă. Toate acestea au impact asupra calității vieții, coeziunii sociale și sustenabilității regiunilor.

Cuvinte-cheie: *piețe locale ale forței de muncă, angajare, mobilitate, strategia privind ocuparea forței de muncă, muncitori imigranți*

Introduction and Objectives

This paper contributes to the current knowledge on labour market evolution and labour mobility by studying the change in the time of the choice of workplace and in the mobility of different segments of the population. Studies of the evolution of sector and gender specific regions over time exist for other countries (Farmer & Fotheringham, 2011; Green, Coombes, & Owen, 1986; Persyn, 2011). This study contributes to the existing literature by examining 11 subgroups in all Spain. In the context of labour mobility, this paper addresses two themes: the difference in the preference of place of work for different subgroups of the population and the change in mobility over time. From the perspective of labour market evolution, this study can help to generate knowledge on where to locate policies and investments designed to stimulate employment growth through focused effort on regions that show job deficits. And whether these policies are compatible with the preferences and mobility

behaviours of different subgroups of the population, also the study contributes to answer the question of where to locate public policies to limit increased mobility through the geographic concentration of the functions of living and working. The paper therefore assesses where the disadvantaged regions are located, indicating where economic growth is needed, and it identifies the mobility preferences of different types of workers.

In order to answer this question, we use commuting data from Spanish workers from the 2001 and 2011 censuses as a case study, thereby adding two qualities to the research. First, this research overcomes previous restrictions, as both censuses report commuting data in both years for workers in all the country. This allows to fill the gap of previous works that have considered only some regions in Spain due the availability of the commuting information. Second, both censuses enables us to address mobility considering the desegregation of the general population in 11 subgroups. The summary of commuters from home to work is used to trace Local

Labour Markets (LLM) due its availability, its material condition over other types of interrelations not subject to the constraints of distance, its character of recurrent process, and the factor of linkage between municipalities of labour and municipalities of residence as an attempt to describe a pattern of activity around urban areas in a typical work day (Feria Toribio, 2008).

Within this research frame, we trace LLMs for all of Spain for 2001 and 2011 using a set of survey-based data from two consecutive censuses (Census of Population and Housing of 2001 and 2011) elaborated by the INE (Instituto Nacional de Estadística, Spanish Statistical Institute) to extract four indexes for each LLM_i in 2001 ($LLM_{i,2001}$) and 2011 ($LLM_{i,2011}$): (1) number of jobs in LLM_i , (2) supply-side self-containment or ratio of resident workers in LLM_i , (3) number of workers in LLM_i , and (4) demand-side self-containment or ratio of jobs occupied by workers that reside in LLM_i . By comparing these four indexes between 2001 and 2011, each LLM_i can be classified into one of five categories suggested by Carrasco and Díaz (2007) (A1, A2, B, C, D). In addition, the data is segmented into 11 subgroups (gender, activity, and sector) due to their different mobility preferences.

By segmenting the population into subgroups we can expand on the evidence reported on other works (Beckman & Goulias, 2008; Coombes, Green, & Owen, 1988; Green et al., 1986; Hansen, 2015; Owen & Green, 2000; Rouwendal, 2004), pointing to the relative independence between one subgroup and another. We aim to avoid generalizing substantial differences in the journeys to work of the different sectors of the workforce (Coombes et al., 1988), as it is unrealistic to assume that all workers are identical in tastes as in income (Rouwendal, 2004).

For instance, Rouwendal (2004) affirms that women have, on average, shorter commutes than men, because a long commute is usually more influenced by professional preferences for woman than for men. In another example, Beckman and Goulias (2008) segregates his sample to consider a finite number of classes of workers related to household size, implying that there is a relationship between household characteristics and commuting distances; however, he does not segregate by gender. About this approach, Rouwendal (2004) suggests that urban economics can predict a clear relationship between household characteristics (including income) and commuting distance, implying that differences among workers result in differences in commuting behaviours. Owen and Green (2000) also highlight that there are spatially concentrated patterns among ethnic groups, remarking on the possibility that this phenomenon could be valid for different occupation groups, activity sectors, genders, or even age.

Further, using a database segmented by gender, Green et al. (1986) prove that there are different patterns of journeys to work and find different degrees of supply-side and demand-side self-containment indexes between males and females. Carrasco and Díaz (2007) also indicate that it is very difficult to separate factors associated with the territory from those related to individual characteristics given that both sides are interspersed. They highlight the differences in terms of mobility between diverse subgroups like gender, level of income, level of education, and household composition. These differences are noted as well by Berdegué et al., (2011) who mentions that they are reflected through decisions about: their living place, capacities, gender systems, ethnicity, and other factors. Casado-Díaz (2000) recognizes how the relationship between place of work and residence varies both territorially and depending on gender, sector of activity, and occupation, explaining that the differences between subgroups could be explained by factors such as earnings, family responsibilities, car ownership, and number of hours of work. Thus revealing a set of overlapping labour market areas specific to gender, age, socioeconomic position, occupational and industrial activity, product of different access to transportation, and other resources (Green et al., 1986). When design of area is performed using aggregate data, such divisions are "averaged" away (Green et al., 1986).

It should be mentioned that the sample is a description of behaviours and individual decisions about the need for mobility required for work reasons, and it is a measure of the demand for mobility required by a certain population. A complete analysis requires knowledge of the supply of public transportation and how this supply meets the needs of the working population, although the use of number of daily trips to work between municipalities as the primary source of information brings implied geographic features (rivers, major roads, railway lines, open spaces, etc.), as Openshaw, Alvindes, and Whalley (1998) point out.

Knowing the benefits obtained through using functional labour markets instead of administrative regions, it is difficult to explain why it is not a more widespread practice or even mandatory in every small and medium enterprise (SME) for planning or project evaluation. To understand the problematic that tracing functional regions implies, it is necessary to consider that there is a wide range of methodologies with their respective algorithms and different ways of proceeding, all with particular nuances that lead to different results. Taking this into account, efforts have been made to resolve this problem and works have been carried out that propose a classification of regionalization techniques (Duque, Ramos, & Surinach, 2007; Fischer, 1980; Gordon, 1996;

Murtagh, 1985; Williams, 2005). Even so, much space remains for subjectivity, as Johnston, (1968) mentions, both in the techniques and in the tracing of the functional regions. This leads us to speculate that the wide range of methodologies and subjectivity are some of the primary reasons that the tracing of functional regions is not a widespread practice among small and medium enterprises and smaller organizations.

Methodology and Materials

Data

Every 10 years, the Spanish Statistical Institute conducts the Census of Population and Housing. The surveys conducted in 2001 and 2011 allow us to examine a set of worker characteristics in detail (gender, occupation, activity, place of residence, place of work). Because the census is conducted periodically (every 10 years), it is possible to detect general changes or evolutions in the information. Therefore, we can determine changes in the demographic space assessing the mobility structure or labour market situation, synthesizing and presenting very specific explorations. In this case of study, the sample (Table 1) is stratified by: gender, occupation (agriculture, services, construction, and manufacturing), and activity (professional, white collar work, skilled manual work, and unskilled manual work). The commuters of each strata trace *LLM* for both 2001 and 2011, which are then classified into *LLM* that change from surplus areas in jobs to deficit areas or vice versa, due to the variation of workers, jobs, and two self-containment indexes.

Table 1: Short description of the sub-groups used in this study

Strata	Census 2001	Census 2011
	Key of Classification:	Key of Classification:
<i>General Population</i>		
<i>Women</i>	6	6
<i>Men</i>	1	1
	National Classification of Activities (CNAE-93):	National Classification of Activities (CNAE-09):
<i>Agriculture</i>	1	1
<i>Manufacture</i>	15-37	10-33
<i>Construction</i>	45	41,42,43
<i>Services</i>	38-44	34-40

	National Classification of Occupations (CNO-94):	National Classification of Occupations (CNO-11):
<i>Administrators, Professionals and Technicians</i>	10-35	11-38
<i>Supervisors and Not Manual Workers</i>	40-53	41-59
<i>Manual Qualified Workers</i>	60-78	61-78
<i>Not Qualified Manual Workers</i>	80-97	81-97

Source: National Institute of Statistics, Spain; Censuses of Population 2001 and 2011

It should be noted that in the 2001 and 2011 censuses, the information concerning place of residence and place of work for people living in municipalities with less than 20,000 inhabitants has been recoded. To safeguard statistical secrecy, the name of the municipality has been substituted for a keyword assigned depending on the number of inhabitants, since it is impossible to analyze these municipalities where removed from this study.

Methodology

The purpose of the methodology is to trace *LLM*, maximizing the internal homogeneity within *LLM*, and the heterogeneity between different *LLM*, allowing us to consider each *LLM* as different and individual analytical unit. To this end, we use commuter data that captures the relationships between areas to quantify the role of each area within the network. Let T_{ij} denote the number of workers that reside in area i and work in j . In that case, $\sum_{j=1}^n T_{ij}$ is the total number of workers in area i (this figure includes the internal flows T_{ii}); $\sum_{j=1}^n T_{ji}$ is the total number of jobs in area i (again this figure includes T_{ii}). The aim of each of the $N-1$ steps of the algorithm used for the delimitation of *LLM* is to maximize the self-containment of the generated areas (number of jobs occupied by residents of the area and number of residents working in the same area) as well as a geographical continuum. Our objective is to identify poles and generate areas of influence through an objective function described later in the text. The delimitation procedure is done for both years (2001 and 2011). For each, $LLM_{i,2001}$ and $LLM_{i,2011}$, four indexes are calculated: number of jobs, supply-side self-containment, number of workers, and demand-side self-containment. The variation of these four indexes between 2001 and 2011 allows us to place

each LLM_i into one of five categories (A1, A2, B, C, and D), as suggested by Carrasco and Díaz (2007).

Delimitation of Local Labour Markets

The methodology chosen is an iterative process with $N-1$ steps based on the calculus of indicators that measure the intensity of the commuter flows between pairs of areas, merging in each of the $N - 1$ steps the two most related areas. In each step, two areas are grouped and the interaction between these two areas becomes an internal interaction (or intrazonal) for a new resulting area. This new area now takes the place of the two parent areas in the next step of the analysis (De Jong & Van der Vaart, 2010). This methodology, used on the trip origin-destination matrix, allows us to infer groups of homogeneous regions in terms of the number of people living in an area who share destinations in their daily commute to work. These regions (LLM) are formed by municipalities, and we consider them to be similar if workers have similar destinations (work) and origins (residence) in their daily life. Namely, two areas are considered similar if people living in these two municipalities have similar destinations in their commute. Specifically, in every $N - 1$ steps of the agglomerating process the objective function:

$$\frac{T_{ij}}{(\sum_i T_{ij} * \sum_j T_{ij})} + \frac{T_{ji}}{(\sum_j T_{ji} * \sum_i T_{ji})} \quad (1)$$

is maximized,

where:

T_{ij} is the interaction between origin i and destination j .

In tracing functional regions, it is necessary to conduct robustness checks with different conformations to evaluate which of all the possible conformations forms groups that are as homogeneous as possible internally and as different as possible between regions. Since this agglomeration process, at each stage, merges the two regions with the strongest possible commuting ties, it is suitable for determining the optimal number of agglomerations and their content. To this end, ANOVA is used to verify statistically significant relationships within each LLM . Based on the idea that to form regions such that the municipalities in a group share the same LLM while elements in another region have a completely different behaviour, it is possible to check if there are significant differences between the areas obtained.

Changes in the Local Labour Markets between 2001 and 2011

To examine the change of each LLM_i between 2001 and 2011, we calculate four indexes for $LLM_{i,2001}$ and $LLM_{i,2011}$. Thus, the four indexes are:

- 1) Supply-side self-containment of LLM_i is

$$\frac{T_{ii}}{\sum_{j=1}^n T_{ij}} \quad (2)$$

and resumes the percentage of resident workers in a LLM_i who work inside the boundaries of the same LLM_i

- 2) Demand-side self-containment of LLM_i is

$$\frac{T_{ii}}{\sum_{j=1}^n T_{ji}} \quad (3)$$

and resumes the percentage of the jobs available in the LLM_i that are occupied by workers who reside in the same LLM_i . In both indexes, the higher the index the more "closed" the LLM_i , and the functional interaction with the other LLM_i is lower.

- 3) Number of jobs on LLM_i is

$$\sum_{j=1}^n T_{ji} \quad (4)$$

- 4) Number of workers on LLM_i is

$$\sum_{j=1}^n T_{ij} \quad (5)$$

The change of each LLM_i is summarized by five categories depending on their behaviour summarized by the change in indexes between 2001 and 2011: supply-side and demand-side self-containment, jobs and workers. The categories used in this case study are similar to those used in the work of Carrasco and Díaz (2007); the categories (A1, A2, B, C, and D) are:

A) LLM_i shows a reduction in the self-containment indexes but strong growth in employment and workers. This behaviour has two nuances:

A1) LLM_i with small self-containment indexes, indicating functional interaction with neighbouring areas.

A2) LLM_i where the self-containment indexes of demand are lower than the self-containment indexes of supply, indicating the existence of an important offer of jobs.

B) LLM_i reduces its self-containment indexes significantly, but the indexes that resume the number of workers and jobs doesn't change.

C) LLM_i that barely reduces their self-containment indexes and show losses in employment and workers.

D) LLM_i that barely modifies levels of self-containment but shows strong growth in jobs and workers.

Results

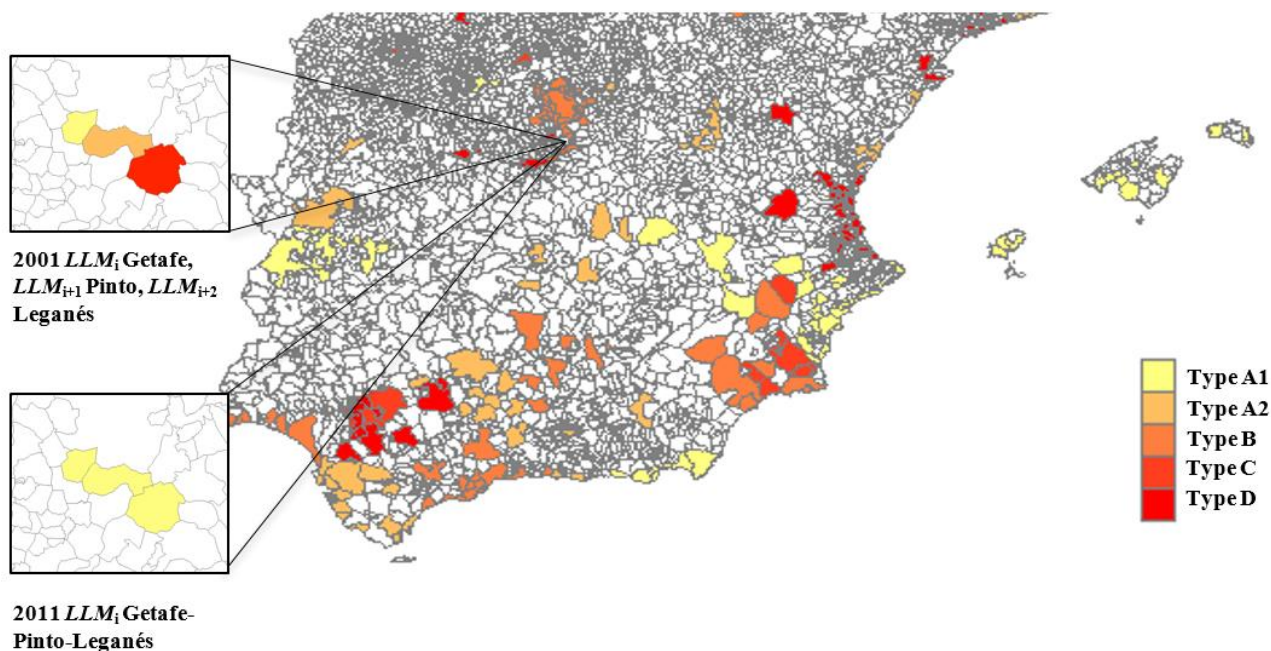
Some of the most representative and clear cases of each of the five behaviours are summarized in the figures of the following section. To summarize this information, each LLM_i is named in the same way as the most populated municipality of the group that forms the LLM_i .

A) An LLM_i that reduces its self-containment indexes of demand and supply but in a context of strong growth in employment and workers. Gives way in 2011 to wider functional areas. The levels of self-containment from which it starts in 2001 is usually relatively low, giving rise to two situations:

A1) An LLM_i with small self-containment indexes, which indicates the existence of crossed flows and a tendency toward the functional interrelation with neighbouring areas. In the first case, it is more representative of an LLM_i located in an urban or metropolitan environment with closed, non-polarized links with the surrounding

LLM_i Carrasco and Díaz (2007). The clearest example in this exercise is in the female segment (Fig. 1), where the three LLM_s identified as Getafe, Leganés, and Pinto, which were three single LLM_s in 2001, fuse to become a single market in 2011.

A2) An LLM_i where the self-containment index of demand is lower than the self-containment index of supply, which indicates the existence of an important offer of jobs and the capacity to attract flows of workers from the neighbouring areas. Since they are close to more dynamic areas with regards to employment growth (Type A) they become part of them. Hence, these LLM_s disappear as autonomous markets between 2001 and 2011. The case of San Cristobal de la Laguna and Tacoronte LLM that become one LLM together with Orotava in 2011 is the clearest example in the female segment (Fig. 2).

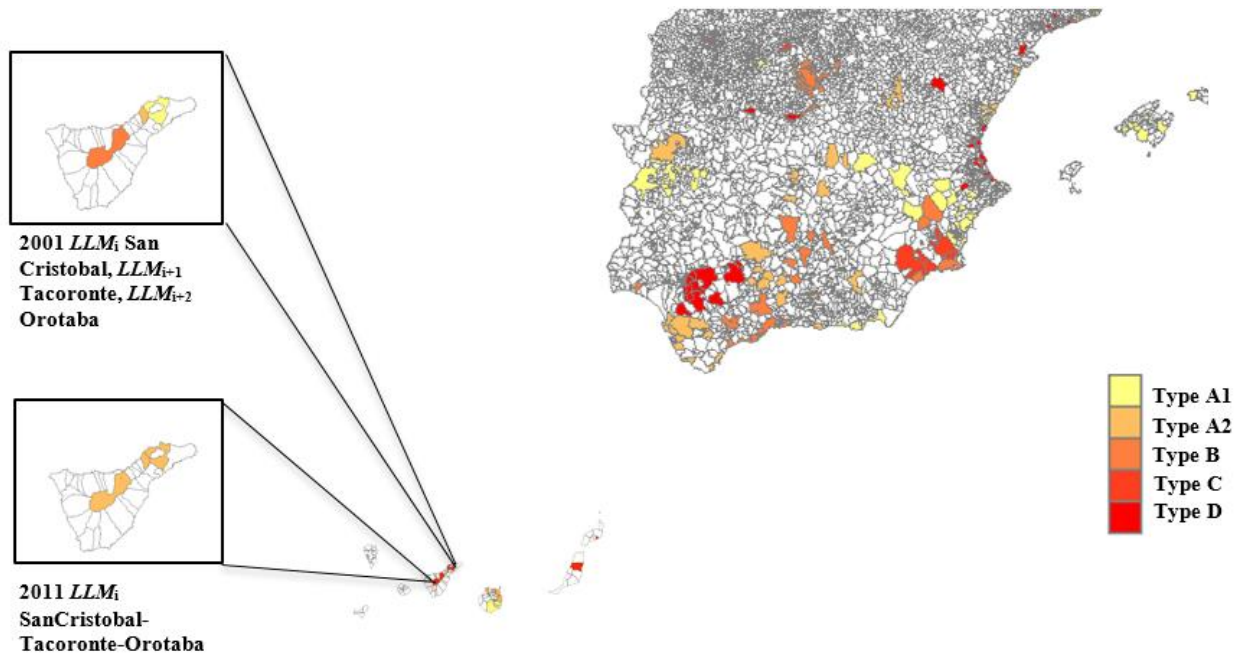


Source: Own Elaboration

Fig. 1: Typology of behaviour of the LLM_i in 2001-2011 (Female Segment)

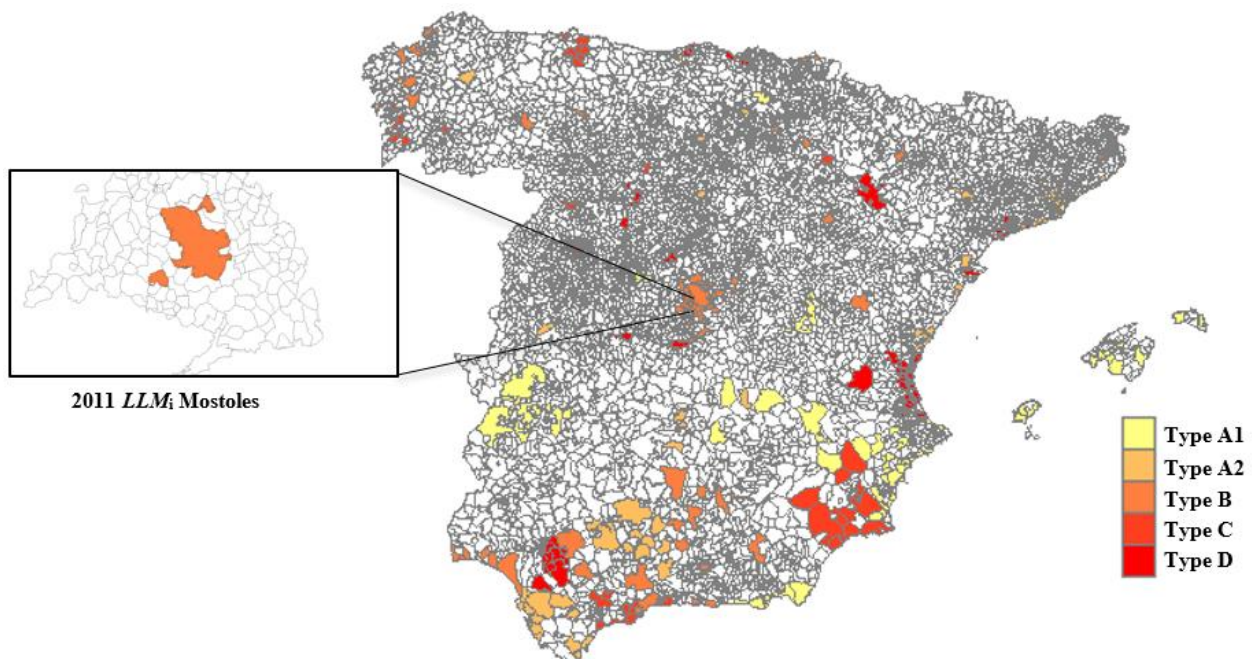
B) An LLM_i that significantly reduces its levels of self-containment in a context of stagnation or recession of the number of jobs and workers. Usually these LLM_s have a level of self-containment of supply that is lower than the self-containment of demand, identifying themselves as areas with a deficit of jobs

and a predominance of outflows over inflows. The case of the LLM identified as Mostoles, which is geographically close to the Madrid LLM , is a very clear example of this behaviour in the Not Qualified Manual Workers segment (Fig. 3).



Source: Own Elaboration

Fig. 2: Typology of behaviour of the LLM_i in 2001-2011 (Female Segment)

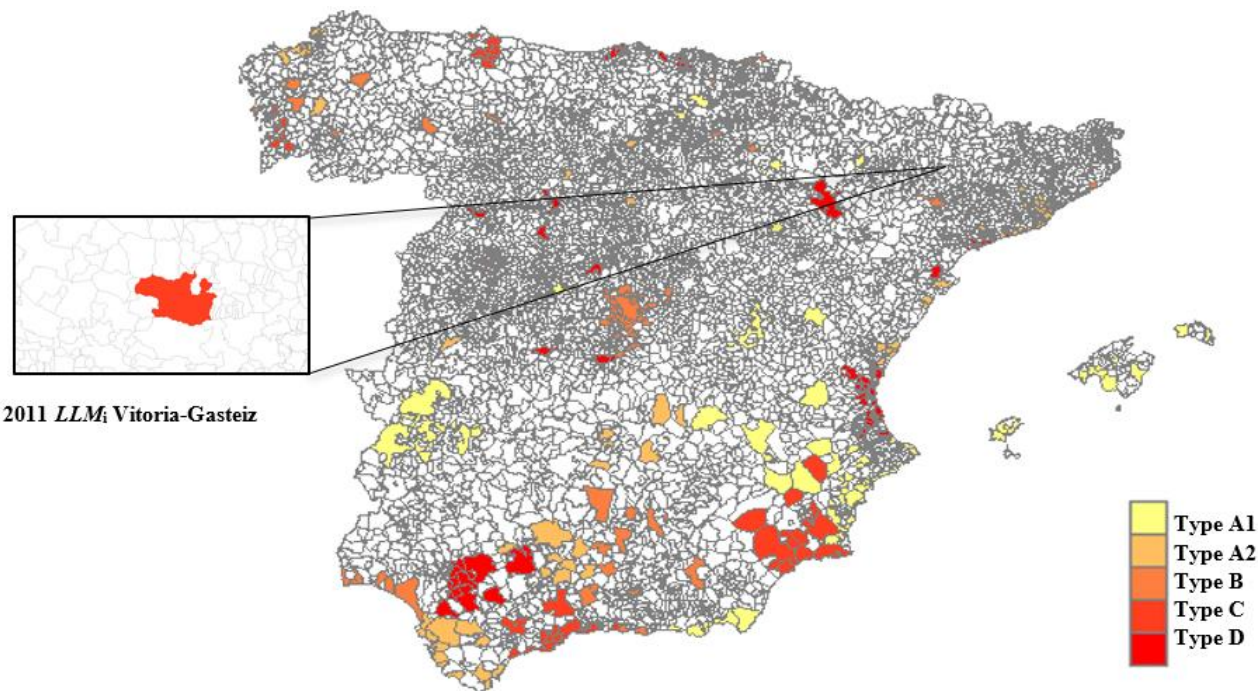


Source: Own Elaboration

Fig. 3: Typology of behaviour of the LLM_i in 2001-2011 (Not Qualified Manual Workers Segment)

C) An LLM_i that barely reduces its levels of self-containment despite experiencing losses in employment and a reduction in the number of workers. This type of LLM starts from high levels of self-containment and, because they are far from a more dynamic LLM , they maintain the same structure between 2001 and 2011. There is a very clear

example of this behaviour in the Qualified Manual Workers segment (Fig. 4), where the LLM identified as Vitoria-Gasteiz in the Basque Country acts as an isolated LLM due to its geographic location and the fact that is the predominant source of jobs for the surrounding area.

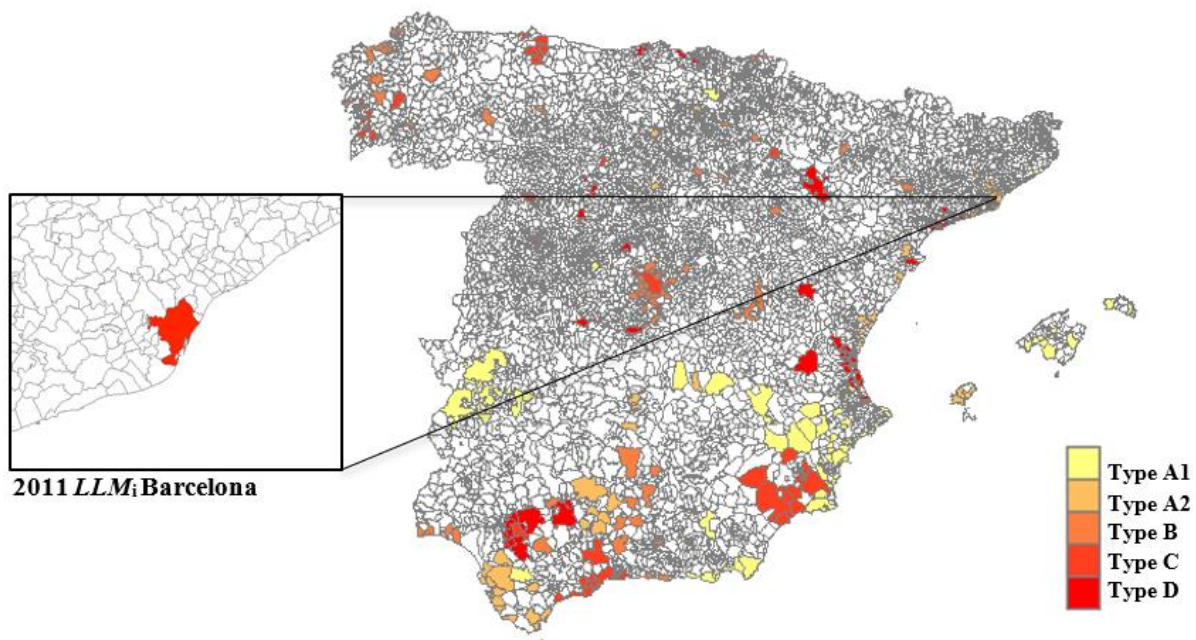


Source: Own Elaboration

Fig. 4: Typology of behaviour of the LLM_i in 2001-2011 (Qualified Manual Workers Segment)

D) An LLM_i that barely modifies its levels of self-containment despite experiencing strong growth in jobs and workers. This type of LLM starts out from strong levels of self-containment, and despite modifying them slightly, they maintain their low articulated pattern, related to the abundance of

middle-sized cities. The most representative cases in the Manufacture segment (Fig. 5) are the $LLMs$ identified as Palma, Algeciras, Barcelona, and Zaragoza. The Manufacture segment is shown, because it has the second most important deficit of jobs in 2011 after the Construction sector.



Source: Own Elaboration

Fig. 5: Typology of behaviour of the LLM_i in 2001-2011 (Manufacture Segment)

In 2001, *LLMs* formed by female and qualified manual workers show indexes of self-containment of supply that are comparable to or higher than the indexes of self-containment of demand, an indication of offer of jobs and capacity to attract of workers from other regions. This situation is reversed in 2011 (Table 2). In 2011, the supply indexes are lower than the demand indexes, demonstrating that the *LLM* formed by female workers turned, in general, to deficit areas in employment with a predominance of

outflows over inflows. This situation can be observed in the *LLMs* formed by male workers and qualified manual workers. A reverse situation occurs in the *LLM* formed by agricultural workers. The Agricultural *LLMs* change to surplus areas with the capacity to attract workers from other regions in 2011 from deficit areas with a predominance of outflows over inflows in 2001. This indicates a recovery of agricultural jobs in the inlands as shown in the flows of immigration.

	Census 2011		Census 2001	
	Supply-Side Self-Containment	Demand-Side Self-Containment	Supply-Side Self-Containment	Demand-Side Self-Containment
Strata:	Mean	Mean	Mean	Mean
<i>General Population</i>	83.2%	84.6%	88.5%	86.3%
<i>Women</i>	82.1%	83.9%	90.6%	88.7%
<i>Men</i>	73.9%	78.1%	86.1%	85.6%
National Classification of Activities:				
<i>Agriculture</i>	80.5%	79.2%	85.9%	88.9%
<i>Manufacture</i>	84.5%	89.6%	82.1%	83.8%
<i>Construction</i>	81.4%	88.5%	85%	85.9%
<i>Services</i>	72.3%	73.2%	73.1%	73.8%
National Classification of Occupations:				
<i>Administrators, Professionals and Technicians</i>	66.4%	71.4%	62.5%	69.6%
<i>Supervisors and Not Manual Workers</i>	78.1%	79.3%	81.4%	77.2%
<i>Manual Qualified Workers</i>	82.1%	85.6%	86.1%	84.4%
<i>Not Qualified Manual Workers</i>	86.3%	88.1%	85.3%	83.2%

The *LLM* formed by workers employed in the Construction, No Qualified Manual Workers, and Manufacture segments display indexes of self-containment that are representative of deficit markets in both years. Although the deficit increases in 2011, and it is captured by a wider difference between the self-containment indexes of 2001 and 2011, the self-containment index of supply is lower than the self-containment index of demand, indicating a deficit of jobs and a predominance of outflows over inflows.

The levels of self-containment (supply and demand) of the *LLMs* formed only by female workers

are higher than for male workers in both years, indicating that the *LLMs* formed by female workers are more closed and that the functional interaction with other *LLMs* is lower for women than for men. This indicates that female workers tend to reside inside the same *LLM* in higher percentages than male workers. This is because the commute to work is more influenced by women's professional preferences than it is for men. In both years, the mobility between segments shows that the Administrative Professionals and Technicians segment has the highest tendency to commute followed by the Male segment. The

segment with the least propensity to commute is the Female segment followed by the Construction segment. This result that shows a higher commuting distance in the segment of Administrative Professionals and Technicians contradicts the assumption that a higher wage rate would lead to a shorter commute. A possible explanation is that workers with high earnings are often highly educated and specialized. As a consequence, the segment of the labour market that is relevant to them is smaller than for other segments. Moreover, these workers also have preferences with respect to housing that restrict their choice sets to a small segment of the housing market, which may imply that the satisfactory combinations residence and work can only be realized at the cost of accepting long commutes.

In general, there is an increase in mobility as a consequence of the decrease in self-containment between 2001 and 2011, as shown in the decrease of the indexes of supply and demand for the Female, Male, Agriculture, and Construction segments. The Manufacture, Not Qualified Manual Workers, and Administrative Professionals and Technicians segments show a decrease in mobility. In summary, there is an increment in the inter-municipal flows in all territories, pointing to a global increase in mobility. The indexes of self-containment show a reduction in the concentration of flows, meaning that the urban interaction between regions increases. Beside this tendency, a classification of the *LLM* is done considering their variation between both years in the indexes of employment and number of workers, and in the self-containment indexes of demand and supply.

We find that there are areas with an important offer of jobs that have the capacity to attract flows of workers from the neighbouring areas. Areas that show a deficit of jobs could be helped with policy and resource allocation. Our evidence also shows different behaviours of the workforce that match with the characteristics of each segment of our subgroups. The segment with the highest tendency to commute is the Administrative Professionals and Technicians segment followed by the Male segment. The segment with the least propensity to commute is the Female segment followed by the Construction segment. This behaviour is evidenced by levels of self-containment (both supply and demand) of the *LLMs* formed only by female workers, which are higher than for male workers in both years, indicating that *LLMs* formed by female workers are more closed in terms of outflows and inflows and that the functional interaction with other *LLMs* is lower for women than for men. This indicates that a higher percentage of female workers reside inside the same *LLM* than male workers. A possible explanation is that the commute

to work is more influenced by professional preferences for females than for males, backing up previous findings about this issue in the literature (Hansen 2015).

With respect to the Construction, No Qualified Manual Workers, and Manufacture segments, their indexes of self-containment are representative of deficit markets in both years, although the deficit increases in 2011. This is captured by a wider difference between the self-containment indexes of 2001 and 2011, as the self-containment index of supply is lower than the self-containment index of demand, indicating a deficit of jobs and a predominance of outflows over inflows in their *LLM*.

The Manufacture and Construction segments were the two most affected, already showing a deficit of jobs in 2001. The deficit increased even more, with the construction sector affected the most since there is a contraction in the supply of jobs and an increase in demand.

There is an increase in the mobility, shown by the decrease of both self-containment indexes between 2001 and 2011, for the Female, Male, Agriculture, and Construction segments. However, the Manufacture, Not Qualified Manual Workers, and Administrative Professionals and Technicians segments show a decrease in the mobility between 2001 and 2011, implying that these three segments had fewer incentives to commute a greater distance in 2011 than in 2001. Also, these three segments show a deficit of jobs in 2011.

Discussion

This investigation contributes to the discussion of the assessment of the geographic tracing of labour markets and the examination of their evolution through time. The paper adds to the literature by investigating how to form functional regions considered as economical attraction poles and proposed as individual analytical regions. Moreover, this investigation contributes to meet with the desired characteristics for analytical regions mentioned recurrently, like: compactness, contiguity (Garfinkel & Nemhauser, 1970), restrictions of size, shape (Rossiter & Johnston, 1981), and natural barriers of the geography like mountains and rivers or lakes (Zoltners & Sinha, 1983) that limit territorial connectivity (Horn, 2010). The chosen methodology limits the use of arbitrary and subjective decisions and helps to ensure that the regions are optimized according to the information under study (existing social, economic, and business ties between the municipalities). The technique also produces a coherent regionalization and is easy to interpret without the need for a contiguous matrix. Furthermore, it contributes to the literature (Atkinson-Palombo & Kuby, 2011; Boermans,

Roelfsema, Zhang., 2011; Carey, 1966; Plane & Heins, 2003) that proposes that economic agents are subject to forces that exert different pressure in each geographic location. It evaluates their main hypotheses with methodologies that analyse the information contained in variables generated by phenomena influenced by the location of economic and social agents. These works are based on the supposition that there are factors that act at a local level that influence the social and economic activity of each region. The approach applied in this paper improves the discussion on two fronts. First, it desegregates the general population into 11 strata, recognizing the different needs of the people that compose the workforce and their different mobility habits through their self-containment indexes, which allows for a deeper analysis of the areas. In this regard, our results show that the intrinsic characteristics of the workforce affect its mobility preferences (Hansen, 2015). Hansen (2015) points out that there are gender differences in terms of choice of workplace, because women are more influenced by professional preferences; job content matters, and it motivates mobility for highly skilled labour. Second, the empirical evidence to evaluate the evolution of the *LLM* is constructed with data extracted from the 2001 and 2011 censuses, which allows us to capture the impact on labour conditions through an important economic contraction.

Conclusions and Policy Implications

The results show an increase of inter-municipal flows in all of the territory, pointing to a global increase in mobility, giving way to wider functional areas and lower levels of self-containment reflected in the length of the journey to work. This impacts the quality of life, social cohesion, and the sustainability of the territories. Affected by the increase in vehicle traffic, the territories see higher levels of atmospheric and acoustic contamination, demanding new and specific policies for their ordination. In this sense, commuting flows are relevant for planning purposes in transportation and housing, giving them value as a basis for transportation and economic growth policies. Therefore, the location of houses and jobs at different points in space imply the necessity of costly transportation that should be facilitated by expensive infrastructure, among other types of policy interventions related to government assistance. It is necessary to discuss and eventually recognize, at least in investments and budget allocations, the tensions and inefficiencies resulting from the gap between the functional space and the local government. Treatments specific to environmental management, infrastructure, culture, economic development, municipal education, etc. are likely required. A programmatic recognition of the existence

of functional regions could provide a common map for better coordination of investments and public programs. Thus, it is necessary to encourage the formation of inter-municipal associations to govern these multi-municipal functional spaces through the coordination of local governments. To potentiate such coordination, special programs and funds are a necessary, as is the continuation of existing funds and programs that aim to resolve conjoint problematics. In this effort, the functional delimitations are only useful for policy-making if they clearly outperform the administrative delimitations, and they should exhibit functional similarities and be coherent with particular measures related to the economy and the labour market. *LLMs* articulate a territory and give services to a set of territories, such as investments in education, transportation, commodity markets, and other political policies. These key roles enable these functional regions to carry out sectorial strategies or policies. They join the capacity of a set of cities to provide services, a qualified labour force, and have the potential to innovate and make links with global markets. This could also be applied in terms of educational policy, health, innovation, and cultural policies among others.

The growing problem of increased mobility can be addressed through policies that are focused on several areas. For example, mobility can be addressed through policies focused on locating housing and work facilities at distances easily covered by alternative means of transportation like bicycle or public transportation, limiting the subsequent urbanization of rural zones. Geographically concentrating the functions of housing and work through the promotion of Transit-Oriented Development (TOD) that means constructing high-density home buildings, workplaces, services and shops near mass transport system stations. The construction of proper transportation facilities and services, flexibility of working time, and the availability of complementary services as childcare is also important. Moreover, favourable conditions of the housing market represent an important factor in reducing mobility. Finally, the spread of teleworking can be regarded as a technological and organizational innovation to decrease mobility.

Our findings also allow us to overcome the administrative concept of municipality or city and to identify areas that are more coherent with the increase in labour mobility (Carrasco & Díaz, 2007). These areas, according Cörvers, Hansen, and Bongaerts., (2009), Mitchell and Watts (2010), and Berdegué et al. (2011), could allow for increased coherence in the reporting of statistics on mobility in terms of economic indicators (income level, housing prices, employment, and unemployment rates) and

for comparison with administrative regionalization (Cörvers et al., 2009).

Also due to the disaggregation of the database used in our research, we can see which of the subgroups and in which regions aid is most needed, allowing for focused policy solutions that could have implications by subgroup and region. For example, in groups more susceptible to unemployment (such as unskilled workers and younger workers), this paper helps to explain the structure of their LLMs; e.g., low skilled workers tend to commute shorter distances than higher skilled workers (Immergluck, 1998). Thus, a shortage of appropriate local jobs will tend to raise the unemployment rate of the low skilled, as they may have limited capacity to migrate to job-rich areas given housing costs and poor information networks. Thus, limiting the policies that favour suburban highway construction over urban mass transit could be beneficial, because highways would leave many individuals in impoverished, job-poor neighbourhoods out of luck. Because many individuals lack access to cars and rely more on public transportation or neighbourhood employment, the lack of local opportunities can be a serious issue. All this information is important for policy-makers and governments concerned with the economy, transportation, labour, and housing.

Author contribution

Garcia Leon Omar contributed to the edition correction a writing of the article also edition of the maps, data analysis and software implementation

Pineda Becerril Miguel de Nazareth contributed to the data analysis writing correction and edition of the article, also edition of the maps and software implementation

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