An exploration of the contribution of local labour market areas to the analysis of regional clusters[1]

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Abstract

This paper explores the use of local labour market areas (LLMAs) as an instrument for the analysis of the territorial dimension of industrial clusters. It concentrates on the labour market aspects of clusters and then discusses the usefulness of LLMAs as a territorial basis for the delineation and analysis of regional industrial clusters in several aspects, including their evolution across time. The paper also intends to contribute to the empirical analysis of industrial clusters in Spain. Thus it briefly surveys the research carried out in Spain on commuting and provides a territorial framework for the analysis of regional industrial clusters in Valencia, one of the Spanish regions that have attracted more attention in relation to this issue, and one of the few regions where this analysis can be carried out in absence of data for the whole country. For so doing a set of functional areas is proposed, based on the use of commuting flow data to conduct a regionalisation exercise to define local labour market areas (LLMAs). LLMAs are delineated so that the majority of the interaction between workers seeking jobs and employers recruiting labour occurs within their boundaries (*i.e.* to define boundaries across which relatively few people travel between home and work). This set of areas is produced for the aggregate population, and specific LLMAs are delimited for workers in the service and manufacturing industries, and for manual supervisors and skilled manual workers.

1. INTRODUCTION

The last two decades have witnessed a growing interest for industry clusters among policy makers and researchers. Despite the existence of very different approaches to the issue, most of them would basically agree on the definition of cluster given by a well known handbook on line (Bergman and Feser, 1999), according to what industry clusters are "a group of business enterprises and non-business organizations for whom membership within the group is an important element of each member firm's individual competitiveness. Binding the cluster together are buyer-supplier relationships, or common technologies, common buyers or distribution channels, or common labor pools". The same web book defines a regional industry cluster as "a cluster whose elements share a common regional location, where region is defined as a

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metropolitan area, labor market, or other functional economic unit". In the rest of the paper the term *cluster* is mostly used with this second meaning.

According to Krugman (1991a), the basic reasons for the localization of industrial activity are the existence of both costs to transactions across space and economies of scale in production. Because of the last of these factors, producers have an incentive to concentrate production of each good or service in a limited number of locations and because of the costs of transacting across distance, the preferred locations for each individual producer are those where demand is large or supply of inputs is particularly convenient –which in general are the locations chosen by other producers, this leading to the self-sustaining of industry concentrations.

One relevant question, probably shared with other areas of Economics and other sciences, is the difficulty of producing operative definitions being able to guide the empirical work on clusters. This might be due to the existence of diverse theoretical contexts very frequently arising from different disciplines, such as neo-classical economics, business and management, geography and spatial-planning or sociology, whose ideas are sometimes complementary but could also be contradictory, the empirical results being interpretable in different ways depending on the initial perspective adopted. The interest of policy makers for the issue in the 1980/90s may have also contributed to a deficit in analytical clarity (Gordon and McCann, 2000). But even if one specific approach to industrial localization is chosen, the question remains ta least partially uncertain, since many of the hypotheses formulated in the literature are complex, multidimensional and at least in part inherently difficult to measure in a quantitative way (Cannari and Signorini, 2000).

A reasonable approach to the analysis of clusters is to proceed through two consecutive stages. Thus, before the empirical testing of the supposed effects of the existence of cluster on the performance of an area, it is necessary to find a compromise that allow such areas to be defined as clusters in a way that at least to a certain extent has to be coherent with the definitions given above and if possible uncorrelated with the variables to be used in subsequent analyses (Cannari and Signorini, 2000).

One common first step in many of the analyses on clusters is the identification of the spatial dimension where all the relationships and exchanges described in the literature could potentially take place. For so doing it is necessary to identify the set of areas eligible to be considered as such (or an alternative type of spatial concentration of economic activity), and then a more or less formal procedure has to be applied to different territorial and industrial realities to decide whether or not each of the potential clusters meet the criteria. Very frequently, however, geographical units chosen as a departure for further research are administrative areas, without any consideration of functionality, what can lead to biased analyses in ways some of which are discussed in section 3.

Next section of the paper shows that one of the most quoted distinct features of clusters in the literature on localization is the existence of a pool of skilled labour. It can be argued that one necessary (although not sufficient) condition for the existence of such a pool is the relative self-containment of the area in terms of travel-to-work, a

question which is central in the definition of local labour market areas (LLMAs). In this paper the use of such areas as a territorial basis for the study of industrial phenomena related to clustering and other modalities of industrial organisation is discussed. LLMAs have already been used as a base for the identification of clusters in countries like Italy, but such exercises have not been very frequent in Spain due to factors some of which will be discussed in the paper. The definition of LLMAs itself is not exempted from criticism, which adds to that derived from their use as basic units for the identification of clusters. Some of them relate to the heterogeneity of labour force being subsumed in a method that works with aggregate flows. Some of the implications of such debate for the cluster concept are discussed in section 3, empirical examples being include in section 4 of the paper.

The possible contribution of the research on LLMAs to the understanding of the way clusters evolve through time is also briefly explored in the paper. Thus for example the widening of commuting flows (reflected in the reduction of the number of LLMAs/increase in their average size) can contribute to the softening of the links that are crucial to the existence of clusters, offering to both workers and firms the possibility of accessing larger markets what in turn can contribute to the loss of local specificity, which has been one of the constituent elements of clusters, in favour of new ways of organisation of production less connected to territory.

In the empirical section of the paper we undertake a regionalisation for the autonomous region of Valencia. First we revise some the research carried out in Spain on commuting and introduce the method used. We then briefly describe the patterns of commuting observed in the *Comunidad Valenciana* and define a set of LLMAs for this region (which -in the absence of commuting data for all parts of Spain- is considered representative in terms of urban system and employment structure characteristics) using commuting data derived from the 1991 Census of Population. Finally we concentrate on the definition of sub-group LLMAs (according to workers' industry and occupation) as a way of understanding how the relationship between place of work and residence varies both territorially and depending on sector of activity and occupation. To conclude some further lines for developing the research are reviewed.

2. THE RELEVANCE OF LABOUR IN THE INDUSTRIAL CLUSTER CONCEPT

Marshall, who presented the classic economic analysis of industry localization, identified three reasons for it: the creation of a pooled market for workers with specialised skills which benefits both workers and firms, the provision of nontraded inputs specific to an industry in greater variety and at a lower cost and finally, the flow of information and ideas and the feedback process among the agents that is easier at a local level than over greater distances (Krugman, 1991a). These reasons for industry localization would be described in terms of modern thinking as a labour-market system that maximises the job-matching opportunities between the individual worker and the individual firm, and as the achievement of service economies of scale or scope in the use of public or private capital, and the efficient transfer of technology, respectively (Gordon and McCann, 2000).

In his work Krugman (1991a) deepens each of the Marshallian reasons for localization, and notes how the idea of labour market pooling is associated with uncertainty and increasing returns. Thus in an area characterised by the concentration of firms that use the same kind of skilled labour whose demand, however, is uncertain and not perfectly correlated (due to product differentiation or to the existence of firm-specific production shocks), localization ensures both a lower probability of unemployment and a lower probability of labour shortage (Krugman, 1991b). On the other hand, sufficient economies of scale make firms to prefer concentrating instead of splitting the production process and replicating wide combinations of firms and workers in different sites where transportation costs of final product would be minimised due to a large nearby demand[3]. The benefits of the 'risk-pooling effect' for both workers and firms in these areas can however (Sanromà, 1996) be partially reduced if the areas are characterised by a great product specialisation that would increase the probability of correlated shocks. In such specialised areas other effects, like the multiplicity of information channels (relevant for the access to jobs since informal recruiting systems seem to be very relevant) and the abundance of possibilities for the acquisition of skills, would probably be more relevant.

As has been pointed out, different approaches to the concept of cluster coexist. In Gordon and McCann (2000) three basic types of industrial clusters are identified: the *classic model of pure aggregation*, the *industrial-complex model*, and the *network or club model*. Real observable clusters can be described as being very close to one of these types or to a combination of them. In the first of the types proposed by the authors, the Pure Aggregation Model, no particular observable organisation or interagent loyalty is assumed. Geographical proximity, co-location, is the key element defining the nature of the cluster, where none of the very abundant linkages and matches between economic actors is permanent. This fact contributes to the openness of the cluster to any firm accepting to pay a rent level reflecting the net value of spatial externalities and other location advantages. In this model benefits are assumed to be easily externalised, and the incentive to develop human capital, for example, is limited. Only the investment in human capital required by workers to have access to better jobs would be afforded, although investment could exist in job search and labour search activities. The second type, the Industrial-Complex Model, is based on stable relations among firms, with trading links as a central issue. According to this type of relationships firms act minimising their spatial transactions costs by locating close to other firms with which they have production links. Typical firms constituting these clusters make relevant capital investments and are of large size. Finally, and following the classification of Gordon and McCann (2000), the Social-network Model is based on the 'embeddedness' of the social network of relations between the agents, with a focus in personal relations and trust. In this type spatial concentration contributes to the

[3] Krugman (1991a) also shows that the logics of localization due to labour market performance also operate in a flexible wage rate environment and when firms try to exploit monopsony power in the labour market, this last argumentation resting however in the assumption that workers are geographically mobile (in Hanson, 1998, the structural parameters of Krugman's model are estimated). This has not been, of course, the only approach from mainstream economics to the operation of regional clusters. For a recent contribution see, for example, Belleflamme *et al.* (2000) and the works cited there.

strength of cultural and personal links among actors in clusters which incorporate firms that are willing to (i) undertake risky co-operative and joint-ventures without fear of opportunism, (ii) reorganise their relationships without fear of reprisals and (iii) act as a group in support of common mutually beneficial goals. These clusters are conceived as being nor open nor closed since the entrance of new partners give them the access to a chance to become integrated in the network (something that will finally happen or not depending on their ability to develop personal relations and trust that link them with the previous participants in the cluster). In this case, since the co-location is a necessary but not sufficient condition for access to the benefits of the belonging to the cluster, local rental values will only partially capitalise the benefits of admission.

From an empirical point of view, the testing strategy that better fits each of these types agrees with their distinct characteristics. According to Gordon and McCann (2000), in the case of the pure agglomeration model, agglomeration processes should be reflected in productivity, growth and local factor prices, among which land and labour, the relations between firms and between them and mobile factors being assumed to be dynamic and difficult to identify. The existence and performance of the second type, the industrial-complex model, can be tested through the analysis of both the relationship between spatial transactions costs (transport costs, telecommunications costs and logistic costs, among others) and geographical distance, and firms' production functions (in terms of input-output requirements). In this case the existence of the industrial cluster could not to affect local land values, since the complex is quite closed to the entrance of new participants given the stability of the relations between the constituent firms which have no incentives to stimulate the arrival of new partners. Finally, the social-network model requires a more qualitative testing intended to evaluate the co-operative behaviour of firms and organisations (through joint-ventures or lobbying actions, among other). In Bergman and Feser (1999) a wide set of the empirical strategies actually used and many case studies are reviewed.

The existence of a local labour market with specific characteristics (relatively self-contained in geographical terms, integrated by workers with relatively specialised skills, flexible, able to contribute to innovation and so on) seems a key feature in almost all the types of clusters described in the literature. Thus despite the existence of a number of different classifications of externalities, including a wide list of proposed effects, that have attracted the attention of researchers from different disciplines and schools (see Costa-Campi and Viladecans-Marsal, 1999, for a summary), those related to labour in a broad sense are undoubtedly crucial, and have been pointed out to be reflected in the improvement of the search and job-match possibilities and in the accumulation of knowledge on labour skills in the local workforce.

It is out of the scope of this paper to analyse the behaviour of labour market in specific clusters. However, some results on the performance of such market in different types of industrial agglomeration in Italy and Spain may illustrate how the existence of the *pooled market for workers with specialised skills which benefits both workers and firms* mentioned above works in reality. Casavola *et al.* (2000) survey some of the Italian contributions to the issue and point out how, according to some authors, labour market in the typical industrial district is characterised by large segmentation, with a significant number of workers with a high human capital being rewarded with wages

that exceed those in non-district similar firms (frequently accessed through mobility between firms or the transition to independent working). Simultaneously, an abundance of on average younger new entrants in the districts labour markets is observed, where firms play the role of educating them in the specific skills required to developed their professional activity in the sector (and not only in the firm), and whose wages are probably lower when compared to their counterparts in non-district firms. In their research Casavola *et al.* (2000) find that average wages for new entrants are not significantly lower than those in firms out of the district after controlling for several features of sector, territory, education and age, whilst similar analysis on workers with higher experience allows concluding that their wage is similar and sometimes exceeds that of non-district firms for almost of ages. In their analysis on 23 *local productive systems*[4] across Spain, Costa *et al.* (1993)[5] found that firms in these areas employed workers whose levels of qualification exceed the average, provided more stable jobs (although a high relative functional mobility was observed within the firms), used mainly informal channels for the recruitment of labour (a recruitment usually restricted to the local market) and were involved in on average more numerous actions intended for the transmission of specialised skills, all these features leading to the development of important internal markets both at the firm and notably the *local system* level.

3. The contribution of Local labour market areas to the definition and analysis of industrial clusters

As has been pointed out in the first section of this paper, the production of operative definitions able to guide empirical analysis on clusters has proved to be difficult, due to the alternative analytical approaches to the issue, to the inherent complexity of clusters and to the qualitative nature of many of its constituent elements, but also to the scarcity of detailed quantitative data. It seems necessary, however, to define a procedure that allows the analysis of clusters and the empirical testing of the hypothesis proposed in literature, and the comparison of the results obtained in different environments defined in terms of institutions, urban structure and traditions, among other factors, to assess the existence of a 'district effect' independent to certain territories, and the possibilities of policy actions for sustaining or even fostering it.

The identification of the set of areas eligible for being considered as regional industrial clusters seem a logical step before carrying out further analysis and comparison. Taking administrative units as a departing point without investigation on their ability to capture functional reality seems arbitrary. With minor variations all the concepts of industrial cluster presented in the previous sections implicitly or explicitly lead to the conclusion that the territorial boundaries of regional clusters broadly coincide with those of the attached labour market. This labour market is of crucial importance for the performance of the cluster, and is one of its distinct constituent

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[4] A *sistema productivo local*, or *sistema local de empresas*, is defined as being constituted by a number of small and intermediate firms localised in a geographical area where formal and informal links develop among them. These areas can be considered as a flexible interpretation of Marshallian industrial districts, whose distinct features do no exactly fit these areas (Sanromà, 1996).

[5] The results of this research are discussed in Costa (1992), Sanromà and Roig (1992), and Sanromà (1996).

elements: "a local production system represents a local pool for specialised labour. The movement of labour between the firms allows an efficient transfer of knowledge and technology between firms, facilitates learning, innovation and faster development of new products and processes. Labour market flows enable the firms to cumulatively build on a shared set of technological experiences and tacit knowledge. Firms compete for specialised labour and individuals benefit through having the ability to move easily between firms. In a cluster workers have at their disposal a wider range of jobs capable of enabling them to achieve their job ambitions" (Cappellin, 2002:15). Of course, other dimensions of the definition of clusters would be probably equally acceptable as a departing point of this task. However, the absence of nation wide detailed data on other phenomena describing relationships among the agents in the cluster which could be considered as relevant[6] make it useful to employ commuting data for the empirical delineation of clusters.

Two variables seem crucial in this context. Self-containment and sufficient size, both aspects being fundamental in industrial clusters' labour markets, are clearly linked through a trade-off relationship. On the one hand, there is a need for a high degree of self-containment in terms of travel-to-work[7] given the importance of the local specificity and the relevance of accumulative tacit non codified knowledge and intensity of relationships among the agents in the cluster environment. On the other hand, the pool of labour has to be wide enough to guarantee the feasibility of the benefits attached to the performance of clusters in terms of job-matching possibilities. The existence of the localised market for labour is assumed to be simultaneously beneficial for both workers and firms. On workers' side, for example, these benefits are in part linked with the reduction of the probability of unemployment due to the relatively high abundance of jobs for which they are eligible according to the specific skills they acquire during their working life. If the pool of jobs or the pool of workers is too narrow the reasons for localisation are reduced.

Of course, the existence of a self-contained and sufficiently large localised labour market does not guarantee that the complex set of features that characterises clusters' labour markets operates. However, this seems a reasonable compromise around the minimum requirements for such markets to be considered eligible to constitute a cluster.

It has been recognised for many years that the administrative areas often used as geographical units for research and policy making purposes do not provide a meaningful insight of the functional reality into the territory. This is the origin of a long tradition of regionalisation exercises, many of which based upon labour market variables. A local labour market area (LLMAs) intends to represent an area where the majority of the interaction between workers seeking jobs and employers recruiting labour occurs (*i.e.* its boundaries are defined so that relatively few people travel between home and work across them). LLMAs have been widely used in the United

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[6] Like would be for example the case of very detailed input-output tables with at municipality level.

[7] And maybe also in terms of migration, this question requiring detailed further analysis.

Kingdom, the European country with a longer and more stable history of delimitation of such areas. There TTWAs (a specific set of LLMAs) are the territorial reference for the calculation of local unemployment rates, and have been used as a tool to monitor the effectiveness of labour market programmes. They are the basic geography for many researchers analysing local economies and the Department of Trade and Industry use them as building blocks for the construction of Assisted Area maps. They are also used for the identification of development areas (such as EU Objective 2 regions) and contributed to the debate on the reorganisation of local government.

Self-containment and minimum size are key issues in the definition of TTWAs and similar functional areas. From the beginning TTWAs[8] took into account commuting data[9] in their definition and in the sets of TTWAs derived from the last three censuses this data was the core input of the process. The interest for commuting was influenced by the introduction of the American concept of Standard Metropolitan Areas which evolved into the concept of the 'daily urban system' in an attempt to describe the pattern of activity around urban areas on a typical working day using a method based upon work trips. Different authors conducted regionalisation exercises testing changes in the methods used[10]. After some decades when less formal procedures were used, the research of Smart (1974)[11] introduced relevant innovations in the method used for the delineation of TTWAs, adapting some criteria used for the definition of metropolitan areas in the US to eliminate a pattern that was considered to be too centrifugal. Later revisions of the TTWAs map were carried out through procedures increasingly sophisticated (Coombes *et al.,* 1986; ONS and Coombes, 1998) that were also used to define LLMAs in Italy (Istat-Irpet, 1986, and Istat, 1997), Spain (Casado-Díaz, 2000a and b), Denmark (Andersen, 2002) and New Zeeland (Papps y Newell, 2002). LLMAs have been also defined in the Netherlands (Van der Laan, 1991 and Van der Laan and Schalke, 2001), France and Germany (see EUROSTAT, 1992, for a summary of the methods followed in these two countries) and Sweden (Statistics Sweden, 1992), among other countries.

When attention is only paid to input-output flows of goods and services, or to manufacturing specialisation and concentration of small and medium enterprises, for example, a relevant point is missed. Municipalities where economic activity

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[8] In the United Kingdom TTWAs have been defined and review since the 1950s (Ministry of Labour, 1960, 1965; Department of Employment, 1968, 1970, 1978, 1984, ONS, 1998). Such review of TTWA boundaries is a sensitive issue, since it alters the series of data on local unemployment and if for example a ward is removed from an area which is entitled to Objective 2 funding, then that ward losses the benefits.

[9] The use of a physical flow may be seen as archaic in a world where the flows of information have become the distinct feature of the new nature of economics. However, despite the predictions of the loss of relevance of the mobility of people once the new means of communication would allow many tasks to be developed in a territorially disseminated way, figures show the rise of the number of people involved in inter-municipality trips, and in the time used in such movements.

[10] A wide list of references can be found in Smart (1974); Coombes *et al*. (1979 and 1982); Ball, (1980); Masser and Scheurwater (1980). The debate on the definition of this kind of areas was not restricted to the United Kingdom. See for example Bellacicco (1992), for other contributions.

[11] See Coombes and Openshaw (1981) for a revision of this method.

concentrates, especially when manufacturing is considered, are very frequently surrounded by municipalities where the residential function is more relevant (the scarce local employment in them being more likely included in the service sector). Considering concentration of industrial activity as an indicator of 'districtness' can keep such municipalities apart from the boundaries of the industrial cluster, thus introducing a bias in the calculation of all kind of socioeconomic indicators and the possible policies initiatives depending on them. The notion of local labour market is intended to include both job centres and their linked housing centres in a single area, and this is also a reasonable requisite to be required to any delineation of regional clusters.

Methods taking administrative areas as the geographical reference for testing the features usually attributed to industrial clusters might also have difficulties for differentiating neighbouring industrial clusters with similar specialisation based on quantitative data, especially when indicators of concentration of industrial activity or average size of firms are considered without information about the links between firms (what in quantitative terms is quite frequent given the common absence of detailed input-output tables with a sufficient level of desegregation). Failure to identify separate clusters can bias the analysis by for example hiding the existence of different evolutions of the respective local labour markets in terms of unemployment. These differences, sometimes perdurable, could be related to the existence of diverse sets of tacit knowledge associated to extreme product differentiation within a certain industry, making feasible commuting (given geographical distance and related transportation costs) not a reasonable alternative for workers[12] in the declining area given their difficulties to meet the very specific skills requirements or to participate in the (very infrequently based on informal links) recruitment processes.

The use of LLMAs as a base for identifying clusters is not new. Much of the relevant theoretical discussion and empirical contributions on clusters have developed, especially but not only in Italy, around one specific type, the *distretti industriali*[13]. Industrial districts have been identified in Italy following a two-step procedure (Sforzi, 1996, and Istat, 1997). Firstly local labour market areas (*sistemi locali del lavoro*, SLL) were delineated through a simplification of the algorithm used for the delineation of Travel-to-Work Areas in the United Kingdom[14] to process data on commuting flows between comuni *from* the 1991 Census of Population. In the second step those *sistemi locali del lavoro* matching the following conditions were classified as industrial districts: (i) the share of manufacturing workers over total non agriculture workers

[12] This could be an explanation for the empirical observations in certain industrial clusters in the region of Valencia, Spain, where further analysis is needed. An alternative explanation could be of course the existence of informal economy with an uneven distribution across territory reducing reliability of unemployment figures.

[13] Which is defined in Bergman and Feser (1999), drawing on Rosenfeld and Harrison, as "a highly geographically concentrated group of companies that either work directly or indirectly for the same end market, share values and knowledge so important that they define a cultural environment, and are specifically linked to another in a complex mix of competition and cooperation. Key sources of competitiveness are elements of trust, solidarity, and cooperation between firms, a result of a close intertwining of economic, social, and community relations".

[14] The Italian and the British methods are summarised in EUROSTAT (1992).

exceeded national average (ii) the share of manufacturing workers in firms with less than 250 workers was higher than national average (iii) if in one or more manufacturing industries the share of workers over total manufacturing workers was higher than national average, at least in one of these industries the share of workers in firms with less than 250 workers had to exceed national average.

This procedure for the definition of industrial districts is subject to criticisms. One of the main criticism of this method (one that also applies for the first step) is that both the variables and the specific set of thresholds included in the process are arbitrarily selected. Additionally, the results would, at least potentially, be very influenced by the desegregation level chosen in the economic sector classification (Cannari and Signorini, 2000). The perverse effect of these factors is considered to be reinforced by the dichotomised result: whether or not an area is an industrial district.

Most significant criticism is probably that directed against the determinism in the model, and the assumption that the requisites listed above (relative relevance of manufacturing industry, specialisation and relative abundance of small and medium enterprises) are sufficient to guarantee that the set of positive effects associated with the existence of an industrial district in the Marshallian sense take place.

The way industrial districts are identified by ISTAT in Italy is coherent with the *Pure Agglomeration model* type of cluster in the terminology of Gordon and McCann (2000), a model based in the co-location of a sufficiently abundant set of industrial firms with no requirements in terms of co-operation among them, where *profitable local interaction is made possible trough a combination of chance, the law of large numbers (increasing the probability of suitable partners being available) and the natural selection of businesses benefiting from the opportunities on offer* (Gordon and McCann, 2000:517). This may be seen as quite surprising since most of the case studies developed in Italy have underlined the importance of relationships in the Social-network model style defined by Gordon and McCann, marked by the sharing of values and knowledge that result in a cultural environment where words like *trust* and *community relations* are of crucial importance and –it has to be recognised- much more difficult to identify in a general procedure intended to be applied to a whole country.

Measures can be taken however to sophisticate the analysis considering a wider set of variables[15] and a reasonable solution probably requires the development of a highly standardised qualitative procedure to refine the list of industrial districts on a comparable basis. The relevance of an initiative that covers the whole country and provides a frame for the provision of statistics and for the implementation of economic policies cannot however be dismissed. A complementary approach would be calculating

[15] To overcome some of the criticisms cited above, two alternatives were proposed by Cannari and Signorini (2000): a classification of the areas into five categories instead of the two proposed by Sforzi/Istat (industrial district/no industrial district), and alternatively the calculation of a continuous instead of discrete variable able to capture the 'districtness' of an area, taking a wider set of variables into consideration (including a measure of the human capital in the area, the share of workers with an university degree, and indicators of vertical integration, spatial density, public infrastructures – roads-, relevance of exports, and degree of investment in physical capital and technology, among others), the actual interrelation between firms remaining uncertain due to the lack of detailed data.

some kind of indicator of the level of 'districtness' of a zone in the style described in note 15. This could be useful in a policy context, to assess for example the feasibility of measures intending to reinforce the 'district effect' in specific zones, facilitating the transition from potential to real clusters (see Bergman and Feser, 1999).

The operationalisation of LLMAs itself has neither been exempted from criticism. Thus, for example, the selection of thresholds and fixed values for the variables and parameters used in the different algorithms, and the election of the algorithm itself have been considered arbitrary, in a similar way that fixed values in the model of identification of industrial districts have. In addition to this, very different approaches to the delineation of LLMAs have flourished in the last decades; many of them stemming from different theoretical perspectives (see Van der Laan and Schalke, 2001, for a recent classification of these approaches, and Van der Laan, 1991, and 1992 for further considerations). Thus to the critics of the way local labour market is used to define cluster we must add the lack of a consensus on the way such areas should be identified and on their ability to capture the complexity of social life in a broad sense. In this sense, the use of LLMAs as a base for the study of industrial clusters can rejuvenate the debate that aroused when TTWAs were in the United Kingdom defended as true 'daily urban systems' by some authors, who argued that these areas were able to represent the way in which society organises itself in space due to the relevance of commuting flows in daily life, and their influence in the rest of the spheres of society (Casado-Díaz, 2000b).

As it has been pointed out, literature on LLMAs has part of its roots in the US definition of metropolitan areas. One of the main differences between both sets of functional areas is the fact that LLMAs attempt to produce an exhaustive division of national/regional territory leaving no municipality out of it, while metropolitan areas (although strongly drawing on labour market data) deal with highly urbanised areas and so concentrate on certain parts of the territory frequently paying attention to additional factors in addition to commuting[16]. Both basic definitions however could potentially be used as a departure point for the identification of industrial districts, since when the focus is on one specific cluster the procedures designed to identify metropolitan areas would probably be valuable, being able to capture the different levels of linking among the constituent urban elements of the cluster (cases eligible for such an approach are not probably very frequent given the average size of typical clusters according to their nature).

Additionally, LLMAs are a compromise in which aggregate working population is the relevant subject when conducting the regionalisation exercise, the behaviour of the different constituent sub-groups being subsumed in the analysis (see Casado-Díaz, 2000b for a discussion of this issue). Such behaviour is likely to be quite diverse depending on different crucial features, like income, family burdens, age, education, occupation or industry. Casado-Díaz (2001) has quantified the effects of some of these

[16] The procedures have however been in the last years subject to revision. See OMB (1998, 1999, 2000a and b) for a review of the procedures used for the definition of metropolitan areas in the last decades in US, the discussion on the review of the procedures and the standards recently adopted for future delimitations.

features on individual probability of commuting out of the municipality of residence using microdata from the Census of Population.

A narrow point of view would define clusters building upon LLMAs defined for manufacturing workers, using commuting data and a measure of size based on the behaviour of such group. In the extreme we could even select data on commuting for very specific sector groups of workers when defining LLMAs as a first step for the identification of specialised industrial agglomerations[17]. However, clusters are most frequently interpreted as a complex and multidimensional form of organisation. Although manufacturing is still the focus of many analyses, all kind of services (frequently also serving firms and industries in different clusters) play an increasingly important role in the performance and evolution of the aggregation. These service industries include commercial and distribution services, transport and logistics, consultancy in several aspects (including innovation and adaptation of technology), design, marketing, industrial relations specialised firms as well as financial services among others. As Sforzi (1996) points out, the relation between manufacturing and services increasingly overcomes the boundaries between both sectors of activity, and becomes one distinct feature of many clusters, only in part due to a process of externalisation. Of course using overall working population is a compromise when the heterogeneity of labour is considered[18], since the boundaries would be too narrow to describe in perfectly accurate way the behaviour of workers in certain occupations or sectors, and too wide for less mobile groups of workers. However, the same nature of the cluster, that some have described as the result of relations of up to nine different interconnected networks [19] (Cappellin, 2002) diminishes the relevance of the use of average workers behaviour for the delineation of LLMAs. Section 4 in this paper presents some empirical relevance on this issue.

One additional criticism to the use of LLMAs is their variability with time, which has been considered to be inadequate for some uses, notably the definition of areas that are to be used for the production of statistics or the delineation of administrative boundaries in a broader sense. This disadvantage can however be considered as a useful feature since they are intended to provide a meaningful insight of the functional reality into the territory and relates more on the inadequateness of defining such areas using only quantitative information referred to a single set of data.

A clear tendency to the increase in the length of commuting trips has been observed in very different territories and times (Casado-Díaz, 2000b). Since LLMAs definition is based on self-containment, this has been translated into the widening of the

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[17] This would be, for example, the case of workers in a certain sub-sector of activity, or those belonging to specific occupations (as showed in figure 4).

[18] This is in fact one of the basic criteria in the classification of LLMAs approaches proposed by Van der Laan and Schalke (2001).

[19] In his enumeration Cappellin includes technological integration, integration of the local labour market, production integration between the firms, integration between the service sectors and the manufacturing firms, financial integration of the firms, territorial integration at the local level, social and cultural integration, relationships of institutional integration and territorial integration at the interregional and international level.

boundaries of some LLMAs and the fusion of others, with the reduction in the number of LLMAs being the clearer effect of it in the regions where the maps of LLMAs have been reviewed. If clusters are to be identified upon a map of LLMAs, this will led to an almost parallel growth in average cluster's geographical size[20]. Signorini (2000) notes that this may contribute to undermine the nature of industrial districts, in which the existence of a group of firms and people sharing local culture and values play a central role.

Of course the corpus of research on urban growth and industry location is extremely relevant to understand the evolution of clusters and their associated LLMAs, its revision exceeding the scope of this paper. However, a naive exploration of some possible explanations (with very different degrees of probability) for this evolution can be illustrative of the interest of detailed analysis of the changes in the shape of LLMAs as a way of explaining (very frequently less tangible) phenomena taking place in its associated clusters. Let's suppose for example that the LLMA defining the boundaries of one specific cluster expands although economic activity is still extremely concentrated in only a few of the integrating municipalities. In this case, the delineation of LLMA will contribute to capture the decentralisation of residences, something that would remain hidden in a delineation of clusters based on administrative areas. Literature on housing location provides a wide number of possible explanations for such behaviour: it can be an answer to the worsening of living conditions in the proximities of the centre due to congestion, to an increase in housing prices[21] or different types of pollution, or to the increase of incomes allowing access to areas with better amenities or larger houses, all this possible due to the affordability of the cost of transport. This line of explanation describes a district pushing workers to reside in neighbouring areas but able to keep on providing them with jobs.

The de-location of certain manufacturing activities from the cluster in an attempt to benefit from lower wages in certain countries (feasible for those segments of production for which knowledge can be codified) can transform the model. This change may include for example the transition from manufacturing as the leading activity to other specialised in product design and logistics. This evolution that will not be rare in the future can be a possible alternative that would also contribute to produce larger LLMAs, at least marginally. This could be due to the inability of the cluster to provide resident manufacturing workers with jobs in a quantity large enough, for example, and also to the bigger recruitment areas traditionally associated with specialised services[22].

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[20] If for any reason this is considered as undesirable a banal solution would be reducing the requisites in terms of self-commuting, what will lead to a higher number of LLMAs/clusters whose boundaries most probably would not fit the ones based on previous data on commuting, thus reflecting the net result of different forces frequently acting in opposite directions. An alternative would be to keep of considering the original set of LLMAs and analyse less autonomous clusters in terms of commuting flows.

[21] Taltavull and Casado-Díaz (2003) analyse some aspects of this effect using data for the region of Valencia, Spain, in the empirical part of the research.

[22] It is remarkable however that some kind of tacit knowledge will be still relevant for the performance of this new model, the experience in the product being a relevant input for this transition from manufacturing to services activities associated to it.

In an area where an increase of activity is registered it could generate a volume of jobs exceeding local supply for labour. In this case the expansion of boundaries would reflect the growing attraction of the cluster as a job centre that spreads local firms' average recruiting zone. Specific circumstances making immigration more frequent than in-commuting (orography, regulations and public intervention, costs of transports associated to infrastructures, an unlikely lower price of dwellings in the cluster, the arrival of extra-regional immigrants among others) could however allow the growth of the activity in the cluster not to be necessarily linked with a widening in its geographical boundaries. The impact of such immigration in the performance of the cluster will crucially depend on the strength of the local knowledge and the ability of the agents to integrate the incomers and to facilitate the acquisition of specialised skills part of which related to tacit knowledge[23] (these factors also being important to keep local specificity if the flow of in-commuters significantly grows). Additional effects include changes in housing prices and, in general terms, of local prices, this leading to further potential movements of people.

A broader LLMA could also be the result of the operation of *pull factors* related to the scarcity of jobs: it could be the response to an increase in the size of labour force that the growth of economic activity cannot compensate, and the subsequent growth of relationships with surrounding small and medium size localities not belonging to the district but acting as incipient job centres for their resident workers. Stable clusters can be the result of a stationary point in the path of economic growth (a cluster not so dynamic as to attract external workforce, not so declining as to push local workers out of its original boundaries).

Talking generally, the change in the composition of the workforce can also alter commuting flows, as we among others have shown elsewhere through different quantitative procedures (see Casado-Díaz 2000a and 2001). Thus, for example, the increase in the number of people working in the service industry, whose jobs on the whole tend to be more concentrated than industry at least in some regions (see tables 1 and 2), or an average growth of real incomes will expand commuting flows and correlated LLMAs; the feminisation of the labour force and the spread of part time work acting in an opposite direction. The delineation and analysis of sub-group specific sets of LLMAs in the style shown in the next section of the paper can contribute to the quantification of some of these effects when analysing the evolution of specific clusters.

It must be noted that the survival of the cluster as an specific type of economic organisation depends on its ability to reproduce the forces that define its nature (flexibility, innovation, trust, and so on) in a changing environment, but the transition to other forms of organisation not necessarily implying decadence in economic activity or in social dynamism cannot be of course discarded.

[23] On the other hand, in certain circumstances immigration and in-commuting could also foster innovation (and so sustainability of the cluster) given the risks of cultural homogeneity in the cluster noted by some authors.

Many authors have concentrated on the study of the evolution of clusters. Some recent contributions include Signorini (2000), who discusses the likely effects of phenomena like globalisation[24] or technological innovations in the production process on industrial districts and doubts about the supposedly negative impact of such factors in their evolution, trusting on the different types of flexibility that characterises regional clusters. Dei Ottati (1994) notes that the survival of industrial districts depends on an equilibrium between the co-operative elements that allow division of work to prosper and contribute to the integration of the system, and the competitive forces that keep it flexible and innovative, while Becattini and Rullani (1996) underline the relevance of the equilibrium between two type of knowledge, tacit or contextual and explicit or codified knowledge, since innovation processes involve transfer of both[25], and Boari (2001) concentrates in the role of leading firms in the cluster.

One additional key factor to be considered when analysing the evolution of LLMAs and its possible effect on clusters is the incidence of the new means of communication. In the last years phenomena like *telecommuting* have attracted growing interest (see, for example, ECaTT, 2000). Innovation in communication could at least potentially impact on LLMAs/cluster boundaries. As Marshall (1920)[26] noted, "every cheapening of the means of communication, every new facility for the free interchange of ideas between distant places alters the action of the forces which tend to localize industries."

The effect of new means of communication is not restricted to the relation between the firm and its workers, of course. In general terms, it has been noted that their expansion will presumably lead to the loss of some portion of local cultural micro-specificity (Signorini, 2000), so eroding the traditional concept of cluster. New means of communication are influencing the management of the production function, both in terms of the provisioning of physical inputs and in the relationships with the suppliers of traditional and specialised new services. Thus for example the ties with financial service firms, crucial for the performance of clusters could also be weakened, with potentially serious consequences in moments of low growth of economic activity, when trust and personal relationships among agents is of vital importance. Distribution channels for both final products and intermediate goods are also changing, with the higher share of electronic commerce being associated with business-to-business relationships. The growth of the pool of potential suppliers of inputs and *teleworkers* can of course soften the interagent links that define the cluster. But on the other hand, the effect of the possibilities of serving broader markets cannot be dismissed. As Porter (1998:90) points out, "in a global economy –which boasts rapid transformation, high-

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[24] The literature on the relation between globalisation and clusters is abundant. See for example Bellandi (1996) and Becattini and Rullani (1996).

[25] They note that both contextual and codified knowledge are of importance to guarantee the reproduction of agents and relationships that characterise local productive systems. The first of these types has a tacit nature and is tied to the context where it develops, and so constituting a localised resource, specific of a given context (a territory, an organisation). The second type is explicit: thanks to the abstraction power of a code that explains and formalises its meanings, what makes this kind of knowledge applicable beyond the original context.

[26] IV, x, 4.

speed communication, and accessible markets- one would expect location to diminish in importance. But the opposite is true".

The implications of these innovations on the labour market relationships in the cluster is however more central for the aim of this paper. Since the delineation of LLMAs tries to capture the territorial dimension where supply and offer meet in one specific market, the labour market, and since until now this exchange has mainly be based on physical presence of workers, this raise a question that needs further analysis. Telecommuting may be acting softening local specific ties not only in the goods and services markets, but also in the market of factors. Although it seems to be by far less relevant for the manufacturing industry, where physical presence of workers is vital, than for services, part of the jobs in industrial enterprises are related with service activities, many of them being at least potentially eligible for transition to a virtual environment. This will also be the case of many of the functions that firms externalise as a strategy to increase competitiveness. On the other hand, if telecommuting also expands among resident workers in the area, this may reduce out-commuting thus contributing to an increase of self-containment, this of course acting against the widening of LLMA' boundaries.

It must be considered that in the extreme, new means of communication could provoke the change in some cases from a regional industrial cluster to an industrial cluster in the terminology of Bergman and Feser (1999) used in the first section of this paper.

4. DELINEATING LOCAL LABOUR MARKET AREAS IN SPAIN. AN EMPIRICAL EXERCISE

This empirical section of the paper consists on an exercise of delineation of LLMAs in the autonomous region of Valencia that can serve as a first step for the identification of industrial clusters and, above all, as a basis for the analysis of their evolution, something that will be facilitated when commuting data from the 2001 Census of Population will be completely processed. Additionally, the results of similar exercises carried out to define specific LLMAs for diverse sub-groups of workers are presented and briefly discussed.

Research on commuting in Spain has been limited by data availability. Although information can be gathered in surveys, above all in large cities, the procedures of delineation of LLMAs are usually based in data similar to those from the Census of Population. The question on *place of work* was introduced, but not processed, in the forms for 1920 and 1970 censuses. Then in 1981 a sample of 20% of population was processed. In the 1986 data was gathered from the *Padrón Municipal de Habitantes* for some autonomous regions, like Catalonia. Later in the 1991 census of population the question about place of work was not included in the Census forms for all regions. It was an optional question which was only included in eight (out of seventeen) of the regions. Finally, in the 1996 *Padrón Municipal de Habitantes* the question on place of work was eliminated due to changes in the law. However, five autonomous regions[27]

[27] Asturias, Canaries, Catalonia, Navarre and the Basque Country

carried out parallel surveys that allowed the estimation of commuting data between municipalities.

Relevant literature in Spain (most of which in Spanish and Catalan) starts with the analyisis of data from the 1981 census of population in Catalonia (Generalitat de Catalunya, 1995; Clusa *et al.*, 1995), where data served to define LLMAs using a method similar to that of Smart (1974), and Andalusia (Feria, 1992), where regional urban system was analysed. These data was also used to study specific cities (Cortizo, 1984, in Oviedo; see Casado-Díaz, 2000b for a review of the work carried out in Catalonia[28]). The use of abundant sources of information has allowed the development of research that analyses the evolution of commuting into two basic lines, the first of which is that related to local labour market areas (Castañer, Gutiérrez y Vicente, 1995; Clusa y Rodríguez-Bachiller, 1995), that was developed following the method of Smart (1974). The second set of works was devoted to the delineation of intermediate level functional urban areas (*áreas de cohesión*) (Castañer, 1994; Castañer *et al.*, 1998; Generalitat de Catalunya, 1998). Both sets of works have contributed to the *Catalonian Territorial Plan*.

Despite the absence of information for the whole country the availability of information on the journey to work from the 1991 Census of Population has allowed the development of a set of research projects on commuting in a number of autonomous regions. In the region of Valencia data from this census was described in Salom (1996). Journey to work data was afterwards analyse by Casado-Díaz (2001) who studied personal, professional and territory-linked factors influencing commuting behaviour using individual data. Aggregate commuting data was subsequently used by Salom *et al.* (1996) to define intermediate level functional urban areas (*áreas de cohesión*), and local labour market areas using the method proposed by Smart (1974) (Salom *et al*., 1997), and Coombes *et al*. (1986) (Casado-Díaz, 2000a and b). In Andalusia Feria and Susino (1996) carried out a wide analysis of commuting focused on the seven metropolitan areas they defined. Clusa and Roca (1997) defined the metropolitan area of Barcelona by means of the method used by the US Census Bureau. The American method has also been used by Trullén (2001) to define the metropolitan area of Barcelona in his analysis of externals economies in that functional area. Cortizo (2001) described journey to work in Central Asturias and commuting data was used by Juaristi (2002) to identify the hierarchy of metropolitan areas in the Basque Country. The use of commuting data has also been relatively spread among planners, who incorporated them in several territory management proposals without spreading among the academics.

In this paper we basically[29] use the methodology developed by the Centre for Urban and Regional Development Studies (CURDS, University of Newcastle-upon-Tyne) and the British Department of Employment for the Travel-to-Work Areas (TTWAs) revision in 1984 (Coombes *et al*., 1986)[30]. Small changes have been introduced to simplify the interaction with the computer program which has been

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[28] This included, among others, the works of Nunes (1986) and Esteban (1989a and b) on the metropolitan area of Barcelona using 1981 and 1986 data respectively.

[29] Parts of this section draw on Casado-Díaz (2000a).

[30] In 1997 a similar procedure was used in the revision of the TTWAs using data from the 1991 Census of Population (ONS and Coombes, 1998).

specially developed for use in the Spanish analysis. The specific algorithm has been selected because of its wide use in both administrative and research purposes, because it has also been successfully applied in other parts of Europe as stated above and is the basis of the methodology recommended by EUROSTAT (1992).

As has already been pointed out, the method selected has been applied to overall working population and to a set of different workers' sub-groups. The most obvious benchmarks for this second part of the exercise are the manufacturing working population and a specific subset of workers in this group, those specialised workers with a higher level of skills, both groups being considered central in the definition of clusters. Additionally service sector workers' specific LLMAs have been identified as a reference to show to what extent the election of the manufacturing flows will leave aside a variable which could be significant in this analysis, given the relevance of services in a model of production where many activities are externalised and developed by service firms that very frequently conduct similar work for different manufacturing (and other service) firms in a complex network of relations.

Basically the aim of the regionalisation was to group municipalities to create the maximum possible number of LLMAs where most jobs within the area were filled by residents of that area (demand-side self-containment) and most of the resident working population worked in the area (supply-side self-containment)[31].

A few expressions will be useful when explaining the formal procedure:

T_{ij}: commuters from area *i* to area *j*

$\sum_{j=1}^{n} T_{ij}$: total amount of workers in area *i* (this includes internal flows T_{ii})

$\sum_{j=1}^{n} T_{ji}$: total amount of jobs in area *i* (again it includes T_{ii})

$\frac{T_{ii}}{\sum_{j=1}^{n} T_{ij}}$: supply-side self-containment in area *i*

$\frac{T_{ii}}{\sum_{j=1}^{n} T_{ji}}$: demand-side self-containment in area *i*

$\frac{\sum_{j=1}^{n} T_{ji}}{\sum_{j=1}^{n} T_{ij}}$: *job ratio* in area *i*

The procedure applied in the regionalisation can be summarized as follows.

[31] A detailed description of the algorithm can be found in Casado-Díaz (2000b). The TTWAs method also allows for a trade-off which adopts a different formulation.

(i) Identification of potential LLMA foci, using as building blocks the 539 municipalities (20% of those municipalities with the highest job ratio and supply-side self-containment).

(ii) Consideration of the relationships between potential foci. If one focus *i* does not achieve the statistical requirements (minimum self-containment and size) it is necessary to study its merging with focus *j* according to the index:

$$\frac{T_{ij}^2}{\sum_{k=1}^{n} T_{ik} \times \sum_{k=1}^{n} T_{kj}} + \frac{T_{ji}^2}{\sum_{k=1}^{n} T_{jk} \times \sum_{K=1}^{n} T_{ki}}$$

Once two areas have been amalgamated they are considered as a single area for the calculation of the different indexes and functions in all the following stages.

(iii) Consideration of the relationships among the potential foci (or groups of potential foci) and the rest of the zones according to the previous index. We call β_1-β_2 the two extremes of the self-containment interval and β_4-β_3 the extremes of the size interval allowed in the trade-off (where $\beta_1<\beta_2$ and $\beta_4<\beta_3$). It is in this stage where some changes have been introduced with respect to the original algorithm. The original function[32] has been replaced by one considerably less elegant in order to simplify the operation of the regionalisation program used in the Spanish analysis. Also, while in the original algorithm the statistical constraints were introduced in two steps (allowing a relaxed fulfilment of the requirements in a first step and a strict one later) in this research we have reduced this to a "single shot" procedure, so every LLMA should reach the final requirements at every stage.

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[32] The original function was:

$$\min\left[1; \frac{c_1 \times \sum_{k=1}^{n} T_{jk}}{\alpha}; \frac{\left(c_2 \times \sum_{k=1}^{n} T_{jk}\right) + c_3}{\alpha}\right] \times \min\left[1; \frac{T_{jj}}{\max\left(\sum_{k=1}^{n} T_{kj}, \sum_{k=1}^{n} T_{jk}\right) \times \beta}\right]$$

where α represents the size constraint and β the self-containment constraint. Constants c_1, c_2 and c_3 allowed for the desired trade-off. The requirements of self-containment and minimum size were gradually introduced so in a first step a TTWA should have a value over 0.625 and this value was raised to 0.9267 in a second step. In a later step all the TTWAs that could not meet the constraints were broken up and their components reallocated following the ranking defined by the previous function. In our research for the purposes of ranking the eligible TTWAs for "dismembering" and reallocation this function was replaced by the following:

$$min\left[1; \frac{\sum_{k=1}^{n} T_{jk}}{\beta_4}\right] \times min\left[1; \frac{T_{jj}}{max\left(\sum_{k=1}^{n} T_{kj}, \sum_{k=1}^{n} T_{jk}\right) \times \beta_2}\right]$$

(a) If $min\left[\frac{T_{jj}}{\sum_k T_{jk}};\frac{T_{jj}}{\sum_k T_{jk}}\right]<\beta_1$ then zone *j* does not fulfil the requirements

(b) If $\sum_k T_{jk} < \beta_3$ then zone *j* does not fulfil the requirements

(c) If $\sum_k T_{jk} < a + b \cdot min\left[\frac{T_{jj}}{\sum_k T_{jk}};\frac{T_{jj}}{\sum_k T_{jk}}\right]$ then zone *j* does not fulfil the requirements

$$\text{where } a=\beta_2 + b\,\beta_4 \quad \text{and} \quad b=\frac{\beta_2-\beta_1}{\beta_4-\beta_3}$$

(iv) After some iterations of the process (which includes other requisites like a minimum threshold of reciprocity in the exchanges of workers among different areas to be considered as a single LLMA after fulfilling the other criteria) a map of LLMAs is produced in which some non-contiguities are observed. These non-contiguities have been solved, without implying any relaxation of the criteria.

Data provided by the *Valencian Institute of Statistics* (IVE) are presented in the form of eleven squared non-symmetrical matrices where rows display the origins and columns the destinations of the daily flows of people between their municipality of residence and their municipality of work. Available matrices include: aggregate working population and sub-group specific matrices defined by gender (2), industry sector (4) and occupation (4)[33].

Tables 1 and 2 describe some features of the data alternatively using municipalities and individual workers as units for the analysis. In table 1 both supply-side and demand-side self-containment, and the number of localities that act as first destinations for the journey-to-work of the different sub-groups are presented. The latter indicator gives an idea of the spatial pattern of the journey-to-work flows. Where the number of municipalities acting as 'first destinations' for other localities is small the flows are concentrated and the number of different LLMAs expected is smaller. On the other hand, a high number of 'first destinations' must be related to a potentially higher number of LLMAs, (although it will still be necessary to pass a minimum size threshold).

[33] The level of aggregation by occupations was decided by the Valencian Institute of Statistics, being impossible to individually identify the flows corresponding to supervisors and manual skilled workers in manufacturing, construction and mining (the last being however an almost irrelevant sector in the region).

Table 1. Characteristics of the municipalities

Sub-group	% of aggregate flows	Supply-side self-containment		Demand-side self-containment		Number of localities acting as 1st destination (total =539)
		Mean	St.D.	Mean	St.D.	
Total	100%	66%	0.18	79%	0.17	105
Women	29.78%	63%	0.22	78%	0.18	124
Men	70.22%	66%	0.19	79%	0.17	104
Agriculture	8.35%	89%	0.14	92%	0.11	170
Manufacturing	28.30%	51%	0.27	71%	0.25	151
Construction	10.27%	60%	0.25	77%	0.21	122
Services	53.08%	56%	0.20	75%	0.18	80
Supervisors and skilled manual workers in manufacturing and construction	24.88%	58%	0.25	73%	0.24	143

Source: Casado-Díaz (2000a) using data from 1991 Census of Population.
Notes: Unweighted mean. St.D.: Standard deviation. Unweighted Means. Demand-side self-containment: share of jobs in the area filled by residents of that area. Supply-side self-containment: share of the resident working population working in the area.

Table 1 demonstrates large discrepancies between localities in the behaviour of diverse sub-groups of the working population. With regard to industry sector, agriculture and manufacturing are the two extremes with the other two sectors – construction and services- having levels quite close to manufacturing. The number of centres displays a different picture. The pattern is quite divergent for the different sectors, with the number of centres for industry almost doubling the number for services (151 versus 80). A high concentration of jobs is an important feature of service activity while manufacturing has a more dispersed pattern (also shown when Supervisors and skill manual workers are analysed). One interesting fact that is not stated in table 1 is that the city of Valencia, the regional capital which accounts for 21.57% of jobs and 19.73% of workers in the region, acts as first destination of commuting flows for 130 municipalities (9 of which are in the neighbouring province of Castellón) and as second destination of another 62 (12 in the province of Castellón). A very different pattern is observed in the provincial capitals Castellón (first destination for 48 municipalities) and Alicante (first destination for 15 municipalities). These contrasting patterns, easily observed when carrying out the nodal analysis not included in the paper, will undoubtedly lead to LLMAs of different sizes and characteristics.

The results in table 2 compare demand and supply-side self-containment for the different sub-groups on an individual basis. In this table supply and demand-side self-containment levels are similar since the number of jobs and workers are also very alike; the only discrepancies are due to inter-regional commuting. Comparing tables 1 and 2 it is obvious that on average more populated localities follow a pattern of lower self-containment when contrasted with less populated ones, whose self-containment levels are over-weighted when areas are used as the unit of interest (the same general pattern of lower levels of self-containment in larger urban areas is observed in other European countries and other regions of Spain, EUROSTAT, 1992; Palacio, Ed, 1995). Self-containment in the region of Valencia is higher than that observed in other Spanish regions such as Catalonia (Palacio, Ed ,1995) where the level was 64.41% in 1991.

Table 2. Supply and Demand-side self-containment for different sub-groups (individuals as units)

Sub-group	Jobs	Workers	People who work and reside in the same municipality	Supply-side self-containment	Demand-side self-containment
Total	1,204,977	1,217,311	912,914	75.00%	75.76%
Women	359,423	362,517	281,543	77.66%	78.33%
Men	845,554	854,794	631,371	73.86%	74.67%
Agriculture	100,879	101,603	92,631	91.17%	91.82%
Manufacturing	342,276	344,557	239,068	69.38%	69.84%
Construction	123,353	125,053	89,682	71.72%	72.70%
Services	638,469	646,098	491,533	76.08%	76.99%
Supervisors and skilled manual workers in manufacturing and construction	300,716	302,927	216,780	71.56%	72.09%

Source: Casado-Díaz (2000a) using data from 1991 Census of Population.
Note: Demand-side self-containment: share of jobs in the area filled by residents of that area. Supply-side self-containment: share of the resident working population working in the area.

Once the algorithm is selected, the question of the level in the different parameters and variables remains. Different trials of the regionalisation have been undertaken and their geographical interpretability tested before selecting the definitive map of LLMAs to be used in further research. As a measure of the geographical and administrative convenience of a particular regionalisation exercise, the dispersion observed among the zones in terms of surface area and population has been studied (with the number of non-contiguities in the draft zones, before manual adjustment, and the fit to the "traditional perception of space" - this being by far more subjective and difficult to evaluate- acting as secondary criteria). Criteria proposed by EUROSTAT (1992) were also considered.

For this exercise the thresholds were set at a self-containment level (minimum of supply and demand-side self-containment) of at least 75% and a minimum size of 8,500 resident workers. A size/self-containment linear trade-off was allowed so that a zone with 70% self-containment was accepted if the size exceeded 17,000 (the range in the minimum size is equivalent to about 20000-10000 active population)[34]. These self-containment values were fixed in levels similar to those used in the United Kingdom. The minimum size range was established so that the resulting number of areas was similar to that of *comarcas*[35], the basic infraprovincial aggregation of municipalities used by regional administration for statistical purposes and for the development of

[34] Despite using the same method the exercise presented here differs in several parameters to that of Casado-Díaz (2000a). Changes in the self-containment thresholds where introduce together with a modification in one 'reciprocity' parameter (α_4), whose value was established in 0.05 instead of the value 0.1 that had been previously used by the authors (as was in the 1981 and 1991 revision of TTWAs). These changes allowed further subdivision of province of Valencia, what was considered relevant for the aim of this paper, without significantly increasing the number of LLMAs in the province of Alicante.

[35] The autonomous region of Valencia is divided into 34 *comarcas*. Although they partially correspond to the functional reality of the territory mostly historical and geographical factors rather than economic or functional considerations underlie their boundaries and there is still a controversy about their delimitation since no systematic formal procedure was employed.

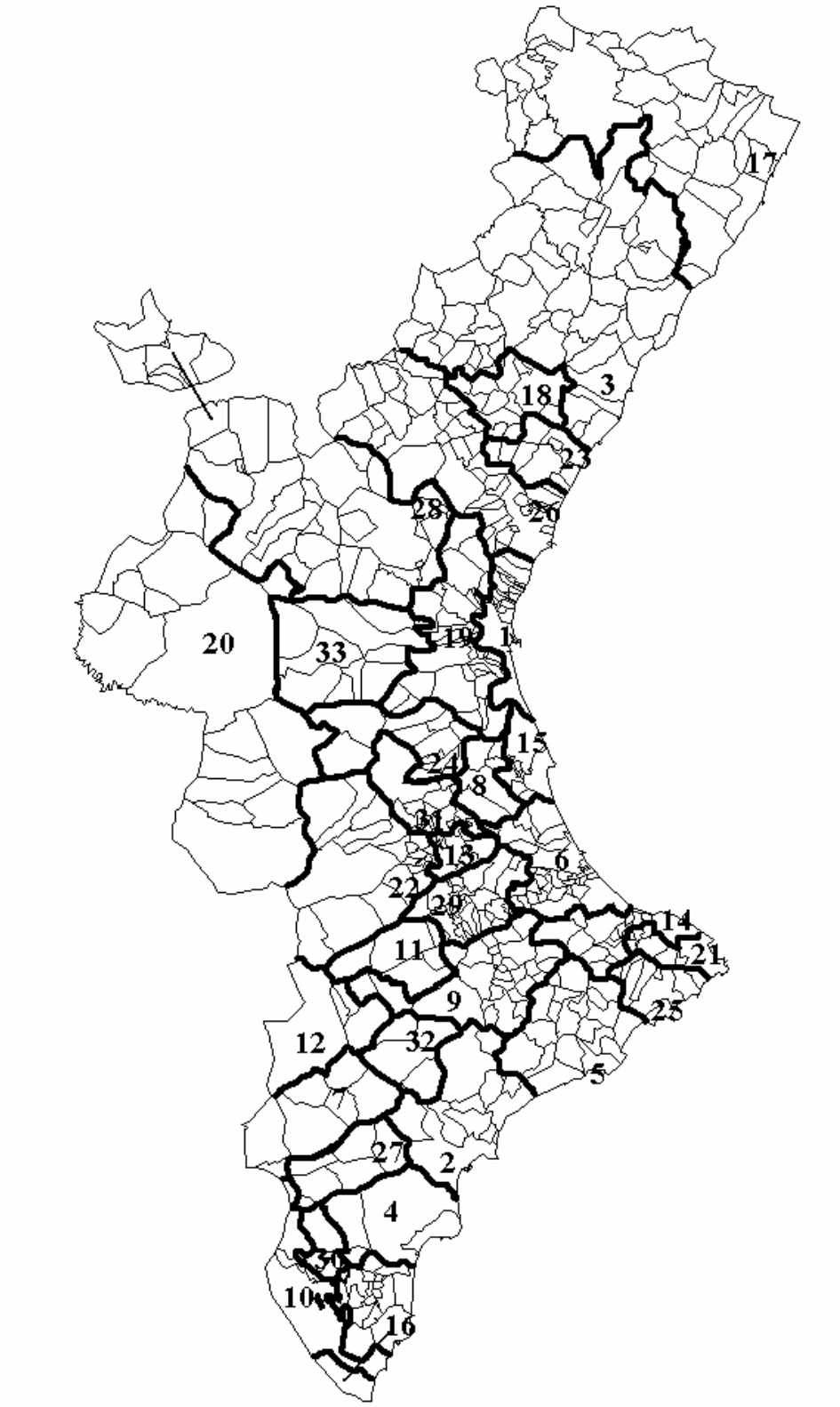
certain policies, this number being considered as *desirable* or *acceptable* by the regional administration. These parameters gave place to a total of 33 LLMAs, a number which is similar to that of *comarcas*, although most of borders do not exactly fit when comparing both classifications. The regionalisation of the *Comunidad Valenciana* (see figure 1) leads to a pattern of LLMAs that is quite different in the different provinces: less numerous in the Northern province of Castellón and more homogeneous in size in the Southern province of Alicante.

Using the same methodology but scaling down the absolute minimum size requirement according to the different sub-group weights[36], specific sub-group LLMAs have been defined. The results are displayed in figures 2, 3 and 4[37]. As observable, the number of LLMAs varies from 25 in the case of the service industry to the 35 areas identified for manufacturing. Daily labour markets for workers belonging to different sub-groups are not the same. Relatively independent markets varying in size from one sub-group to another can be found. Factors such earnings, skills or average size of the firms among others underlie these differences in behaviour.

[36] Minimum size requirements where reduced to the range [4,811-2,405] in the case of manufacturing workers, [9,024-4,512] for the LLMAs based on the workers in the service industry, and [4,230-2,115] for the for manual supervisors and skilled manual workers. Similar exercises were undertaken by Green *et al*. (1986) and Coombes *et al.* (1988) in some regions of the United Kingdom.

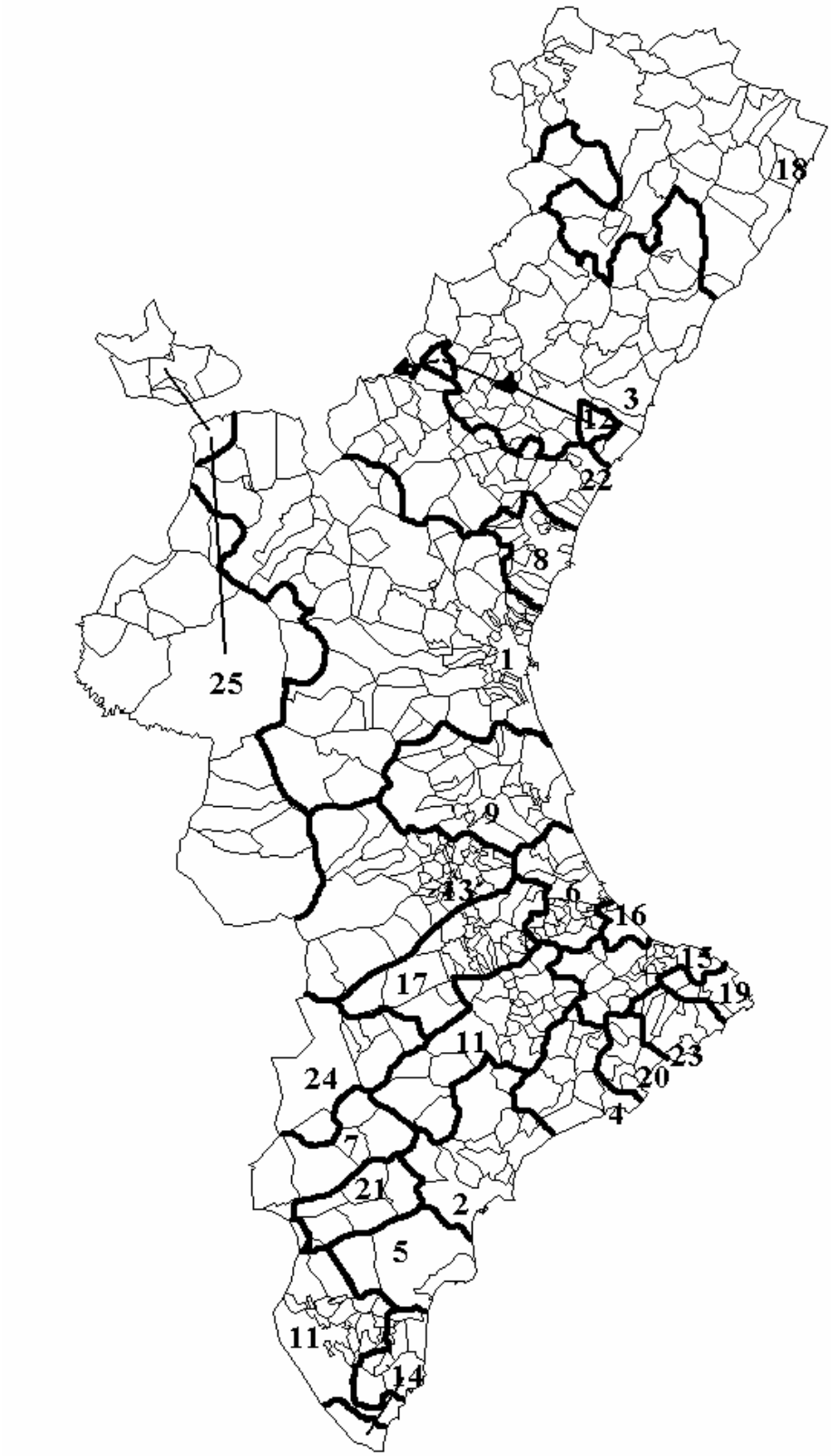
[37] One particular concern when developing this kind of exercises is the sparseness of data. This may result in decreasing interpretability and the regionalisation may suffer from a lack of robustness (Green *et al*, 1986; Coombes *et al*., 1988). For the sake of simplicity in figures 2-4 in the paper municipalities with flows equal to zero for some sub-group have been merged to the LLMAs they belong to when aggregate working population is considered (figure 1).

Figure 1. Local labour market areas for the aggregate working population



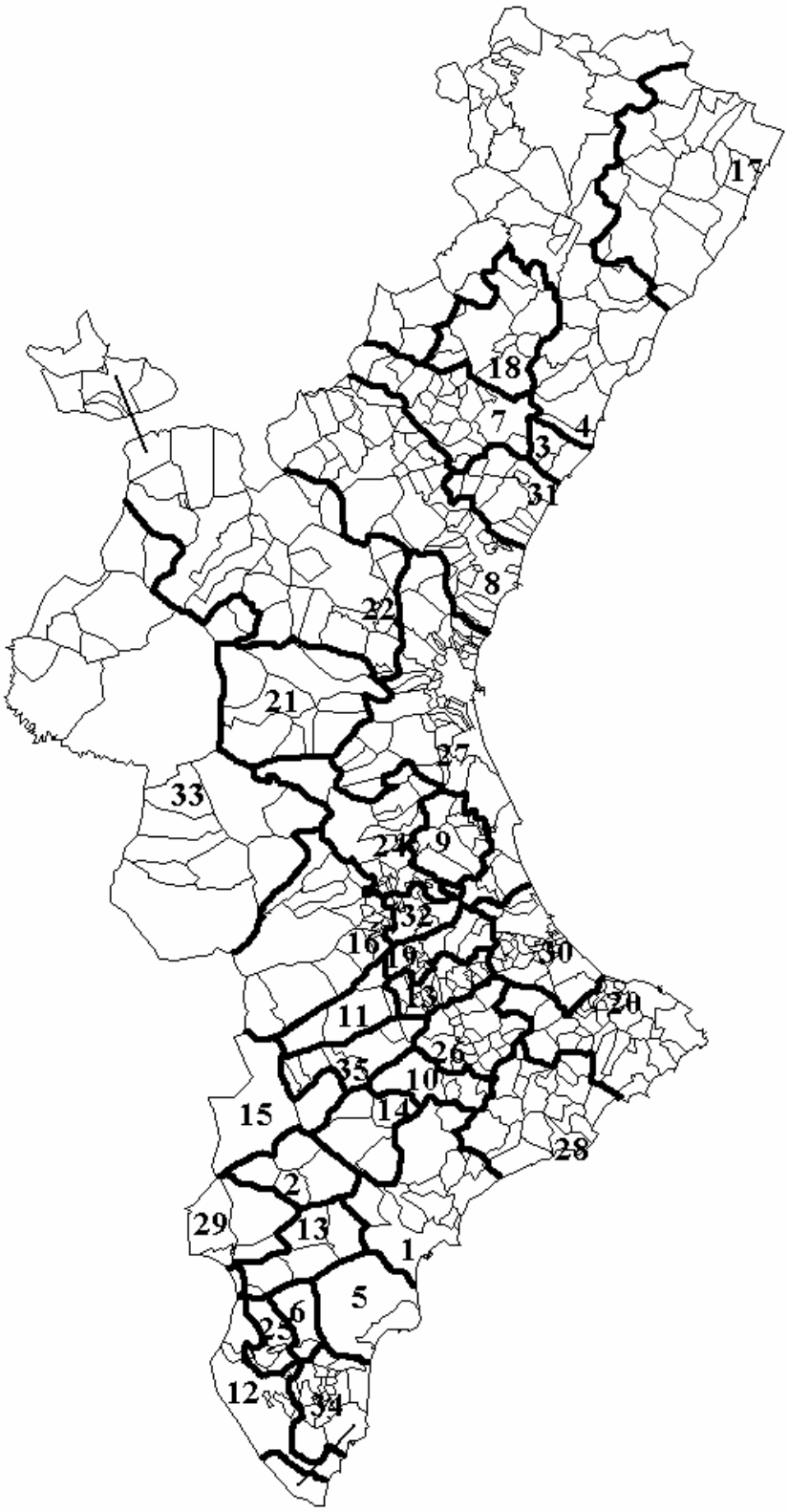
1: Valencia; 2: Alicante; 3: Castellón; 4: Elche; 5: Benidorm; 6: Gandía; 7: Elda; 8: Alzira; 9: Alcoy; 10: Orihuela; 11: Ontinyent; 12: Villena; 13: Xàtiva; 14: Dénia; 15: Sueca; 16: Torrevieja; 17: Benicarló; 18: Onda; 19: Quart de Poblet; 20: Requena; 21: Jávea; 22: Canals; 23: Nules; 24: L'Alcúdia; 25: Calpe; 26: Almenara; 27: Monforte del Cid; 28: Marines; 29: L'Olleria; 30: Cox; 31: Cárcer; 32: Ibi; 33: Buñol.

Figure 2. Local labour market areas for workers in the service industry.



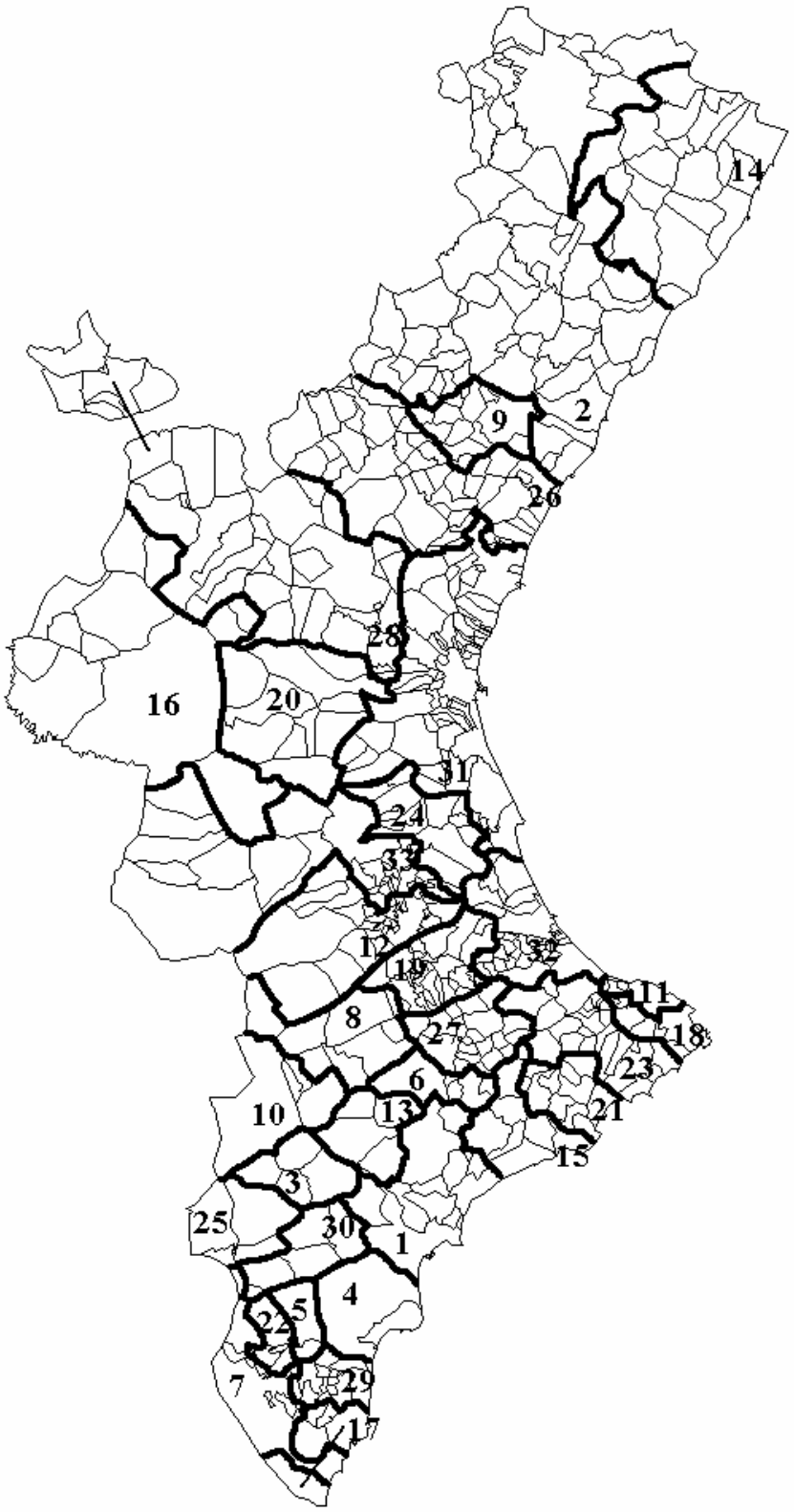
1: Valencia; 2: Alicante; 3: Castellón; 4: Benidorm; 5: Elche; 6: Gandía; 7: Elda; 8: Sagunto; 9: Alzira; 10: Orihuela; 11: Alcoy; 12: Villarreal; 13: Xàtiva; 14: Torrevieja; 15: Dénia; 16: Oliva; 17: Ontinyent; 18: Benicarló; 19: Jávea; 20: Altea; 21: Novelda; 22: Nules; 23: Calpe; 24: Villena; 25: Requena.

Figure 3. Local labour market areas for manufacturing workers.



1: Alicante; 2: Elda; 3: Villarreal; 4: Almazora; 5: Elche; 6: Crevillente; 7: Onda; 8: Sagunto; 9: Alzira; 10: Alcoy; 11: Ontinyent; 12: Orihuela; 13: Novelda; 14: Ibi; 15: Villena; 16: Canals; 17: Benicarló; 18: L'Alcora; 19: L'Olleria; 20: El Verger; 21: Buñol; 22: La Pobla de Vallbona; 23: Albaida; 24: L'Alcúdia; 25: Albatera; 26: Cocentaina; 27: Almussafes; 28: Benidorm; 29: Pinoso; 30: Bellreguard; 31: Nules; 32: Llosa de Ranes; 33: Cofrentes; 34: Benijófar; 35: Banyeres de Mariola.

Figure 4. Local labour market areas for manual supervisors and skilled manual workers.



1: Alicante; 2: Castellón; 3: Elda; 4: Elche; 5: Crevillente; 6: Alcoy; 7: Orihuela; 8: Ontinyent; 9: Onda; 10: Villena; 11: Dénia; 12: Canals; 13: Ibi; 14: Benicarló; 15: Benidorm; 16: Requena; 17: Torrevieja; 18: Jávea, 19: L'Olleria; 20: Buñol; 21: Altea; 22: Albatera; 23: Benissa; 24: L'Alcúdia; 25: Pinoso; 26: Nules; 27: Muro de Alcoy; 28: L'Eliana; 29: Guardamar del Segura; 30: Monforte del Cid; 31: Almussafes; 32: Beniarjó; 33: Masalaves.

The point discussed in the previous section on the relevant set of LLMAs when starting the research on industrial clusters seems less complicated when we go to data, at least in certain regions. Thus the evidence presented in figures 1 to 4, illustrate how the pattern of LLMAs traditionally associated with the existence of industrial districts is very similar in figures 1 (overall working population), 3 (manufacturing workers) and 4 (supervisors and skilled specialised workers in manufacturing and construction), with larger differences being concentrated in the metropolitan area of the capital city of Valencia and in some of the coastal highly tourist areas. This is quite logical a result, since in industrial clusters the behaviour of overall working population is greatly determined by the overrepresented population working in manufacturing. Moreover, the pattern demonstrated in figure 2 (Services) seems quite coherent with common sense, since it corroborates the fact that many services (for example those related with the activity of public sector), but also those associated with services auxiliary to manufacturing activity usually serve wider markets (and frequently diverse sectors of activity). There is not, however, a simple pattern of nesting of LLMAs in figures 3 and 4 into those in figure 2. With regards to the relationship between figures 3 (manufacturing) and 4 (supervisors and skilled manual workers in manufacturing and construction), the similar number of LLMAs identified is also reflected in a similar distribution of them, although even in the areas where the numbers of LLMAs are more closely matched, there are considerable differences between the shape of the LLMAs for manufacturing workers and supervisors and skilled manual workers.

An additional feature to be remarked is the robustness of the boundaries of those LLMAs that roughly correspond with the municipalities that literature on industrial clusters in the region of Valencia have considered as part of such areas. Thus when the sensitivity analysis was carried out to assess the stability of such borders, changes in the different parameters involved in the regionalisation did not significantly alter these boundaries, something that was not true around the metropolitan area of Valencia and the Northern half of that province.

Ybarra (1991) defined industrial districts in the region of Valencia by analysing specialisation in dynamic productive sectors, what led to the identification of nine manufacturing districts specialised in the production of footwear (2), textile products (2), leather articles, toys, ceramic tiles, furniture and marble and stone. The complexes analysed displayed different levels of maturity and diverse technical and productive potentials for the split of the production process. The boundaries of the districts proposed by Ybarra do not exactly fit the ones resulting from the process of the 1991 commuting data by the algorithm as displayed in figure 1, and neither do correspond to the boundaries in figures 3 and 4, the results of this exercise identifying a higher number of LLMAs in some of the clusters[38].

Case studies of the areas that have been considered as industrial districts by different researchers in the region of Valencia are briefly surveyed in Salom and

[38] This could be interpreted as being an evidence of misspecification whose consequences should bear attention, in the style described in section 3. However, the possible existence of clusters where interlinks among firms are abundant and movement of workers is confined within sufficiently populated municipal boundaries –this being reflected in independent LLMAs- should be explored.

Albertos (2000), where the whole references can be found. Following Salom and Albertos (2000), whilst the tile sector experienced a rise in its levels of added value, and employment, furniture, toys, textile and notably the footwear sector suffered a regressive period in the 1980s. The subsequent economic recovery in the following decade displayed an uneven pattern with a leading role of those activities more open to international markets. In the districts specialised in the different steps of the production of footwear (which roughly correspond with LLMAs 12, 7 and 4 in figure 1) firms reacted to the crisis by specialisation and decentralisation of production, which was specially relevant in those parts of the process more intensive in labour, following a price-based strategy that resulted in the proliferation of very small size firms and a rise in hidden economy. This led to dualism between the behaviour of the scarce leader firms and the numerous firms suffering the worsening of their situation. The toy sector industrial district (which almost perfectly matches LLMA 32 in figure 1) also experienced a reduction in the average size of firms, and the vertical disintegration of production which however resulted in the creation of a wide and qualified number of firms specialised in the provision of components with a very dynamic performance thanks to their increasing relationships with other economic sectors like footwear, furniture and the production of cars. Industrial districts related to the textile sector (that correspond to LLMAs 9 and 11 in figure 1) also experienced a tendency to the deepening in the division of labour among firms, but combined with the introduction of new technologies. Large differences aroused however in terms of product design, human capital and international vocation between the diverse firms in the district. Finally, the ceramic tiles industrial district (associated with LLMAs 18, 23 and the Southern part of LLMA 3) witnessed the locking of some firms unable to face the costs of the deep process of technological renovation experienced by the sector, and a simultaneous creation of new firms with bigger financial support. This technological change also contributed to foster the decentralisation of the production process and the development of inter-firm co-operation. These results were broadly corroborated by the research of Salom and Albertos (2000), who conclude that the ceramic tile sector in the north of the region concentrates the higher share of innovative firms, followed by the textile and toy manufacturing in LLMAs 9, 11 and 32 (figure 1), the districts in the south of the region, specialised in the production of footwear being characterised by a share of innovative firms four times lower than that of the ceramic tile sector.

5. CONCLUSIONS

This paper has briefly discussed the relevance of labour in the concept of cluster. Self-containment and minimum size seem crucial in industrial clusters' labour markets. The first of these variables is associated with the relevance given in literature to the local specificity and the relevance of accumulative tacit non codified knowledge as well as to the intensity of relationships among the agents in the cluster. On the other hand, the pool of labour has to be wide enough to guarantee the feasibility of the benefits attached to the performance of clusters in terms of job-matching possibilities. The existence of a self-contained and sufficiently large localised labour market is not sufficient itself to fulfil the complex set of features that characterises clusters' labour markets according to literature. However, this seems a reasonable compromise around the minimum requirements for such markets to be considered eligible to constitute a cluster, the analysis of other relevant factors being reasonable in a second step. Both

variables, self-containment and minimum size, are the base of the method proposed for the delineation of local labour market areas (LLMAs), a set of areas that is defended in the paper as a coherent functional regionalisation useful for the identification of clusters. Of course labour market is not the only constituent element of clusters, given their complex and multidimensional nature. But it is one of the most relevant and, above all, one whose information is possible to measure, and to process in a standardised comparable way. This may contribute to the generalisation of results, this aspect being crucial in the process of testing the hypothesis and models of relationships proposed by cluster literature, one of the only possible ways of accumulate knowledge in such an important field of knowledge.

The concept of LLMAs has been criticised, as has been its use as a base for the delineation of clusters. Some of these aspects have been discussed in section 3, where it has been argued that ignoring LLMAs and taking administrative areas as a reference when studying clusters can cause the analysis to be biased. Thus for example the identification of a cluster on the base of specialisation and average size of firms, could leave aside neighbouring municipalities where most workers live and have functional socioeconomic relationships. It could also lead to the identification of neighbouring municipalities with high levels of similar economic activities as belonging to a single industrial district despite the possible existence of clearly segmented labour markets with different performances and characteristics. The heterogeneity of workers in their commuting behaviour has also been discussed. LLMAs are undoubtedly a compromise describing average pattern of commuting, however this is not considered to be a serious drawback in the paper, some empirical evidence being shown in section 4. Section 3 finishes giving some (it must be recognised) rather vague ideas of how research on LLMAs can be a useful tool to assess the extent of the changes in the shape and size of clusters, and to investigate the reasons for them.

The analysis of the evolution of LLMAs can contribute to the understanding of the changes taking place in their associated clusters, many of which are intangible in nature. Of course commuting is also a complicated phenomenon, the associated data being net results of vectors acting in opposite directions, giving place to both in and out commuting flows. However, detailed analysis on microdata, and the comparative study of different sets of specific maps of LLMAs defined for diverse sub-groups of workers can be quite illustrative and, above all, it introduces quantitative data that can be complementary to other sources of information, among which some qualitative data.

2001 Census of Population have brought substantial changes in the availability of journey to work data in Spain, incorporating questions on place of work, means of transport and duration of the travel-to-work journeys for all the country. Once these data will be available a qualitative change in the nature of the research work carried out until now is expected, given the possibility of analysing commuting at a national level for the first time, linking all different dimensions of mobility to socioeconomic features of population. Until this new set of data is distributed, only regional exercises can be conducted. The regionalisation presented in section 4 demonstrates a delineation of areas for the region of Valencia which is considered to be coherent with the literature on regional industrial clusters, and offers a frame of analysis for the study of the evolution of those LLMAs that could be considered as industrial clusters in 1991. The relationship

between the proposed map of LLMAs and some previous research on Valencian industrial clusters is also discussed in the paper. This map constitutes a first step of an analysis that will include variables like the expansion of housing market in certain areas, changes in infrastructure and the evolution of housing prices and the patterns of migration moves. This research will be completed exploring their impact in the 1991 and 2001-based set of LLMAs and (in certain cases) associate clusters, this comparative analysis being only possible for eight of Spanish regions due to the absence of the relevant data.

To conclude, we would like to note the relevant effort for producing statistical data referred to functional and not administrative areas that have been developing in other countries for several decades. Examples that exhaustively cover national territories are Travel-to-Work Areas in the United Kingdom, and the definition of *sistemi locali del lavoro* and industrial districts in Italy[39]. Despite the sometimes severe criticism these areas have proved to be useful for both policy and research aims. The 2001 Census of Population brings a significant opportunity for the Spanish Government and regional authorities to use data on commuting flows (possibly in combination with other sets of data, both quantitative and qualitative) to produce functional areas to be used in the future.

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[39] Where the tendency to increase the range of indicators at a local functional level continues (see for example ISTAT, 2002).

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