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ABSTRACT

In Madrid, as in other metropolitan regions, the interest in the agglomeration of economic activities, along with the present perspectives of metropolitan competitiveness and the emerging knowledge-based economy, converge on the field of industrial clusters. In this paper we follow the current recommendations about combining mapping strategies. Firstly with a quantitative identification of industrial complexes in the region, considering as an initial hypothesis the existence of significant input-output relationships among co-located industries. Secondly, the qualitative information from politically selected clusters was used to refine the quantitative cluster identification and to evaluate the creation of new firms within Madrid's manufacturing clusters.

Key words: Industrial clusters, industrial-complexes, new industries, Madrid

JEL classification: R110, L16, R300, M13

Clusters industriales y creación de nuevas industrias en el sector manufacturero de la región metropolitana de Madrid

Como en otras regiones metropolitanas, el interés en Madrid por las cuestiones de la aglomeración de las actividades económicas, la competitividad metropolitana y la emergencia de una economía del conocimiento converge en el campo de estudio de los clusters industriales. En este artículo seguimos las últimas recomendaciones acerca de la necesidad de combinar diferentes estrategias para su identificación ("*cluster mapping strategies*"). Primero, con la identificación cuantitativa de complejos-industriales en la región, aceptando como hipótesis inicial la existencia de relaciones input-output entre industrias co-localizadas. Segundo, la información cualitativa de algunos clusters seleccionados en el pasado según criterios políticos, es utilizada para refinar el análisis cuantitativo y para evaluar la creación de nuevas industrias dentro de los clusters industriales de Madrid.

cluster industrial, complejos-industriales, nuevas industrias, Madrid

CRES-2007-0142.R1 (Spanish abstract already provided)

Grappes industrielles et création de nouvelles entreprises dans le secteur manufacturier de la métropole régionale de Madrid

SIMÓN SÁNCHEZ MORAL

RESUME

À Madrid, comme dans d'autres métropoles régionales, l'intérêt dans l'agglomération d'activités économiques, associé aux perspectives actuelles de compétitivité métropolitaine ainsi qu'à l'émergence d'une économie basée sur le savoir, converge vers la création de grappes industrielles. Dans cet article, nous suivons les recommandations actuelles visant à combiner des stratégies de cartographie, premièrement, avec une identification quantitative des complexes industriels de la région, considérant comme hypothèse initiale l'existence de relations importantes entre les entrées et sorties au sein des entreprises regroupées. Deuxièmement, l'information qualitative de grappes sélectionnées a servi à affiner l'identification quantitative des grappes industrielles et à évaluer la création de nouvelles entreprises au sein des grappes industrielles du secteur manufacturier de Madrid.

Mots-clés : grappes industrielles, complexes industriels, nouvelles industries, Madrid.

Classement JEL : R110, L16, R300, M13

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Branchencluster und Firmengründungen im produzierenden Sektor der Metropolregion von Madrid

SIMÓN SÁNCHEZ MORAL

ABSTRACT

In Madrid und anderen Metropolregionen konvergieren das Interesse an der Agglomeration von Wirtschaftstätigkeiten und die gegenwärtigen Perspektiven hinsichtlich der metropolitanen Wettbewerbsfähigkeit und der entstehenden wissensbasierten Ökonomie im Bereich der industriellen Cluster. In diesem Beitrag folgen wir den aktuellen Empfehlungen zur Kombination von Abbildungsstrategien. Zunächst nehmen wir hierfür eine quantitative Identifizierung der Industriekomplexe in der Region vor und gehen als Eingangshypothese von der Existenz signifikanter Input-Output-Beziehungen zwischen Branchen mit gemeinsamem Standort aus. Anschließend nutzen wir die qualitativen Informationen von politisch ausgewählten Clustern zur

Verfeinerung der quantitativen Cluster-Identifizierung und zur Bewertung von Firmenneugründungen innerhalb der produzierenden Cluster von Madrid.

Key words:
Branchencluster
Branchenkomplexe
Neue Branchen
Madrid
JEL classification: R110, L16, R300, M13

INTRODUCTION

There is a growing interest in industrial clusters in the European urban regions from both a multidisciplinary academic point of view and for economic development policies. Along with commonly mentioned potential benefits of clusters (i.e., increased productivity, fostering of start-ups, encouragement of technological advances, etc.) that contribute to metropolitan competitiveness (SCOTT, 1992; SAXENIAN, 1994; PORTER, 1998), it has been recently stressed the key role of clusters in the generation and effective transmission of new knowledge and innovation (OECD, 2001). This has somehow propitiate a reconsideration into the role of urban manufacturing activities, whose necessary contribution to the urban development is linked nowadays with the promotion of strategic clusters in intensive knowledge-based activities (SCOTT, 1988; SWANN et al., 1998; MCDONALD et al., 2007).

Regardless of some critical opinions stressing that there is no inherent reason why the particular relationship between geography and industrial organization observed in clusters should be generally superior to alternative arrangements for localized innovation and growth (GORDON and MACCANN,

2005), the fact is that cluster-based regional planning policies are polarizing the interest of policy-makers.

This is the case with the Metropolis of Madrid whereas the regional government has promoted monographic studies of some "key sectors" and also the involvement of Madrid in the *Cluster Network Project (CLUNET)* of the European Commission, dealing with the identification of policies geared to foster the growth and competitiveness of clusters.

Despite all above, there are only some vague cluster identification initiatives in Madrid (EUROPEAN COMMISSION, 2002). Consequently, due to the well-known controversies in cluster identification (MARTIN and SUNLEY, 2003; MARKUSEN, 2003), in this paper we have followed the current recommendations of the Organisation for Economic Co-operation and Development (OECD) that state "a well-defined cluster identification process should be based on both quantitative approaches (to measure sectoral specialisations and trade flows between firms) and qualitative methods (to understand functional interdependence and knowledge spillovers)" (OECD, 2006, p.19).

Thus, there are two complementary aims in this work. The first is to provide a quantitative framework through a systematic identification of "industrial complexes", considering as an initial hypothesis the existence of significant input-output relationships among co-located industries within clusters. To the best of our knowledge, our study represents the first test of the method described by FESER, SWEENEY and RENSKI (2005) applied to Madrid. We have thus replicated the same input-output analysis whilst *for Local Indicators of Spatial Association* (LISA), a simplified method has been used.

The alternative and simpler proposed model based on LISA (a key contribution of the aforementioned authors within the *extended buyer-supplied value chains approach*) may help to obtain initial data in the field of cluster mapping.

The second aim is to analyse Madrid's clusters from an evolutionary perspective, focusing on new firms' creation as one of the most decisive growth factors. This evaluation required the use of previous data acquired in the mentioned monographic studies in the region of Madrid. Therefore our second aim was limited to the four industrial clusters analysed in those studies, which were selected according to political criteria.

In summary, with this work we endeavour to provide an accurate scope for cluster policies in the Madrid area, beginning with the critical question of clusters mapping. In addition we seek to improve the understanding of the different forms of clustering, development stages, and growth processes of Madrid clusters. The results of this study may help to achieve "taylor-made" policies for cluster development that could replace more generic solutions (OCDE, 2006).

This paper is organized as follows: In the next section, we briefly review the theoretical foundations of cluster concept, focusing on the recent threefold classification of forms of clustering (GORDON and MCCANN, 2000) and the issue of the new industries from the perspective of the life cycle's theory and its recent reinterpretations. In the following section we describe a systematic method to scrutinise supply-demand chains. The final section offers a review of prior monographic studies and an exploratory analysis of new firm creation within Madrid's industrial clusters. The concluding remarks highlight the

interactions between both approaches used in our work and their relevance in policy terms.

INDUSTRIAL CLUSTERS: TYPES AND GROWTH TRENDS

Towards a cluster concept

As it is known, the recent "success" of the cluster concept is often followed by a verification of the troubles caused by the academic heterogeneity of contributions, the hybridisation of original concepts, and certain ambiguities in its subsequent use by policy-makers. This would explain the periodical appearance in relevant scientific papers such as Storper and Harrison (1991), Markusen (1996) and Gordon and McCann (2000) of claims for the necessity of a common language that would make possible the comparison between case studies and the extraction of useful conclusions for the development policies.

Among those contributions, we are especially interested in the deductive classification that recognizes three types of ideal clusters according to the nature of clustered firms and their relations and transactions, *"Model of Pure Agglomeration"*, *"Industrial-complex model"* and *"Social-network model"* (GORDON and MCCANN, 2000).

[Table 1. Industrial clusters: a transactions costs perspective]

As recently summarized by IAMMARINO and MCCANN (2006) (Tabla1), the *pure agglomeration model* refers to a well-known Alfred Marshall's framework (1923) concerning types of externalities (specialised local labour

pool, backward and forward linkages among complementary industries, and information exchanges), which has inspired subsequent reformulations of agglomeration economies, including the principle of *increasing returns to scale* underlying the models of *new economic geography* (KRUGMAN, 1991). The co-location of firms, which are assumed to be small and medium-sized rather than large and monopolistic, may allow them to participate in external benefits. These are usually differentiated in localisation economies (external to firms but related to the size of the industry) and urbanisation economies (external to the industry but related to the size of the local economy).

The *industrial-complex model* focuses on the long-term stable trade relations between firms in the cluster. From this perspective, the purchase-sales patterns strongly influence the location decisions of clustered firms, searching for a minimisation of transaction costs. The resulting cluster, which is most commonly observed in industries such as oil-refining, steel, or chemicals, would be characterised by the presence of some large firms. The access for new competitors is severely restricted by needs of long term investments, particularly in terms of physical capital and local real estate. In this model, the notion of space is not explicitly urban.

The *social-network model*, initially situated within the sociologic tradition (GRANOVETTER, 1973), has been progressively merging into the literature of industrial districts (RODRIGUEZ-POSE, 1998; BECATTINI et al., 2003), and is nowadays converging with the geographic school in the study of the so called *innovative milieux* (AYDALOT, 1986). The main point in this theory line is the existence of trust based relations that would allow a cooperative behaviour between organisations and institutions. In this sense, it has been argued that

the strength and embedded nature of these networks may differentiate the appearance of industrial clusters from other forms of activity agglomeration (GORDON and MCCANN, 2000). On the other hand, the synergist process linking the social networks with the Institutional context of the economic activity remits to the notion of territorial governance and the different forms of proximity among actors (GILLY and WALLET, 2001; MÉNDEZ, 2002).

The possibility of blending the features of the three types into different combinations within real clusters, and the possible shifting from one main type to another, according to the relative stage in their life cycle, enhances the importance of an evolutionary point of view as recently demanded (IAMMARINO and MCCANN, 2006). In this sense, the phenomenon of creation of new industries, one of the most striking factor of clusters' growth as recently confirmed in European urban regions (VAN DEN BERG, BRAUN and VAN WIDEN, 2001), is used as a first indicator of clusters' evolution.

New firm creation and cluster's growth

The creation of the new firms is seen as part of a positive feedback loop, due to its decisive contribution in generating employment and added value, and their useful role as suppliers or innovative partners for incumbents in the cluster. Hence, the collective pool of competitiveness would increase as a consequence of new entries, benefiting all the cluster's members that can advance in comparison with rivals at other locations (PORTER, 1998).

Three interconnected causes of fostering of new firms within the clusters have been at least identified. In the first place, the entrepreneurship has been stressed as a critical element in the formation and viability of innovative

industries and clusters (FELDMAN, FRANCIS and BERCOVITZ, 2005), moving from a more traditional Schumpeterian conception to a renewal perspective of localised networks (MOULAERT and SEKIA, 2003). Thus, the exchanges of information, ideas and innovations would reduce the uncertainty and perceived risk, enhancing the entry of new industries in the cluster, especially when tacit knowledge is needed (SAXENIAN, 1994; POUDER and ST JOHN, 1996).

Secondly, some authors have incorporated the nature of innovating activities to the industry *life cycle's theory* and *technological spillovers*, which describes the levels of entries during the formation stage of a new industry and its subsequent decline. Thus, in accordance with the knowledge conditions underlying an industry an initial differentiation arises between an *entrepreneurial technological regime* and a *routinezed technological regime* (AUDRETSCH and FELDMAN, 1996). Applying this to geographic units, it has been recently highlighted the existence of an *entrepreneurial growth regime*, whereas the high frequency of start-ups and turbulent enterprise structures combine with local socio-institutional networks (SAXENIAN, 1994; AUDRETSCH and FRITSCH, 2002).

Lastly, the lower barriers to entry than elsewhere, as a consequence of the availability of a resource base such as qualified suppliers, skilled workers or informed investors, would generate cost advantages for subsequent firms within the cluster (or agglomeration economies). These factors, plus some institutional ones, represent compelling reasons for new start-ups to continue to locate near competitors (SCOTT, 1992; PORTER, 1998).

Although the history of each cluster may be unique both in terms of early conditions and later development, the analysis of industrial birth patterns has

allowed the defining of several phases within evolutionary models. In this sense, R. POUDER and C. H. ST JOHN have argued that a clustered subgroup of competitors within an industry will likely move through three stages (emergence, convergence and declining), each one characterised by a particular interrelation among the role of resource economies, cognitive frameworks and institutional forces. During the declining stage, when eventually economies of agglomeration will erode and the behaviour of competitors within the "blind cluster" become more complacent and less innovative, the capacity of the hot-spot as an incubator of start-ups and spin-offs may tire out. As a consequence, new firms and some from the former cluster will be born in a new location as they all seek for new sites of agglomeration economies and supportive infrastructure (POUDER and ST JOHN, 1996).

Instead of the traditional perspective of industrial migrations from centres to peripheral locations, which implies that agglomerations are created at early stages of industry development and can only be sustained for a limited time (WOLTER, 2003), there are alternative interpretations claiming the need to distinguish at least two situations: a) Sites that may be seen as centres for innovation (hot-spots), according to the product cycle position of the activities located there; and b) certain sites which remain continuing sites of innovation. Therefore, the production conditions, which allow infant firms and industries to survive and thrive in a nursery environment, become a central question (GORDON and MCCANN, 2005).

In this sense, the urban development theories have already highlighted the role of big (diversified) cities creating static and dynamic advantages for firms in the early innovative phases, like cross-fertilisation and collective

learning processes, size market, or the abundance of skilled labour, sub-contractors and infrastructures (GLAESER et al., 1992; CREVOISIER and CAMAGNI (Eds), 2000). Furthermore, from the point of view of the metaphor of "*nursery cities*" the origin of the mentioned changes in new firms patterns would be consistent with some evidence about the tendency for production to relocate over the life cycle from diversified to specialized cities (frequently in surrounding metropolitan areas), once firms have learnt the production process that exploit later in a new location (DURANTON and PUGA, 2001).

IDENTIFICATION OF INDUSTRIAL-COMPLEXES IN THE REGION

As claimed, the tendency of clusters to change over time makes it more useful to focus on what is less likely to change in the long term rather than attributing them a crystallised set of characteristics (GIULIANI, 2005). Hence, most empirical approximations, including the most successful (PORTER, 1998), are based on a cluster concept that, as a minimum, rely on both the productive specialisation and the geographical proximity.

Both aspects are the basis for an *extended buyer-supplied value chains (filière) approach*, used by us and also claimed as a systematic method to identify the characteristic of geographically localised groups of linked industries (FESER, SWEENEY and RENSKI, 2005). However, industry interconnects includes formal buyer-supplier linkages that have arisen from trading patterns and technological similarities, as well as other factors such as similarities in markets, shared labour pools or exchanges of codified and tacit knowledge, along with existing non trade interdependencies (PORTER, 1990; STORPER,

1997; MIDMORE, MUNDAY and ROBERTS, 2006). In support of our approach, it is claimed that it can generate a reasonable initial baseline for the study of both formal and informal forms of interconnects (FESER, SWEENEY and RENSKI, 2005).

In summary, this approach represents an intermediate solution within the framework drawn by MARTIN and SUNLEY (2003) concerning the methodological solutions to cluster definition and measurement. With this we can bypass the anecdotal evidence collected by a case study approach, and also the simplistic view of many top-down approaches which on many occasions are based only upon mapping exercises of some economic variable, especially when inter-industry trade data for sub-national geographical areas is not available.

Identifying input-output linkages: Method

Although the industrial complex identification method used here is based primarily on the work of CZAMANSKI and DE ABLAS (1979), it has been refined through many subsequent tests, some of which has been published in recent years (FESER, SWEENEY and RENSKI, 2005). Very briefly, the method computes the existing purchases and sales between economics sectors collected by Input-Output symmetric tables in two matrices X and Y, with the elements expressed as follows:

$$x_{ij} = \frac{a_{ij}}{a_{+j}};\ y_{ij} = \frac{a_{ij}}{a_{i+}}$$

where a_{ij} is the value of the product sold by i industry to j industry, and a_{+j} and a_{i+} is the total intermediate goods purchased and sold, respectively, of industry i and j. Then x_{ij} and y_{ij} represent respectively the proportion of value of intermediate purchases and sales between sectors i and j.

Since input-output linkages are complex and multidimensional, appearing not only directly between buyers and suppliers, but also indirectly (i.e. second level suppliers or similar intermediate purchases-sales patterns in apparently unrelated sectors), the method collects in an L matrix the highest of the following coefficients:

$r(x_i . x_j)$: measures the degree to which industries i and j have similar purchasing patterns.

$r(y_i . y_j)$: measures the degree to which industries i and j have similar selling patterns.

$r(x_i . y_j)$: measures the degree to which the selling pattern of industry i is similar to the purchasing pattern of industry j.

$r(x_i . y_j)$: measures the degree to which the purchasing pattern of industry j is similar to the selling pattern of industry i.

Based upon the principal components analysis of this information in the L matrix, the final set would represent a compromise where “primary” and “secondary” activities are assigned to each industrial complex[1].

Consequently, we propose an adaptation of the systematic methodology to the intermediate purchases and sales among extract industries and

manufacturing firms located in the region, considering as well those purchases made outside the Madrid area.

Input-output linkages: Findings

The results from the data of the Madrid's regional input-output framework (2000) observed through the initial eigenvalues plot are the base for a final model with eight components ("candidates" for industrial complexes). These components respectively explain the 19,06%, 11,86%, 10,62%, 9,48%, 9,32%, 7,05%, 5,93% and 4,27% total variance of data, representing more than 77% of the total explained variance (Table 2).

[Table 2. Factor Analysis Total Variance Explained]

[Table 3. Identified industrial complexes]

The first industrial complex would include Publishing, Paper and their products and Glass and Printing products (Table 3). There are also some significant relations between the above and Chemical products (included in the second industrial complex).

The second industrial complex would be formed by Basic chemicals, as a producer of many intermediate inputs for Industrial chemical products and Other chemical products. More difficult to explain would be the presence of other food products. This complex shows weaker relations with Printing products and Pharmaceuticals.

The third group is formed by Other non metallic industries products and Primary metal industries and foundries, having in common the intermediate consumption of products from Extractive industries of non energetic minerals. Other Transportation equipment and Metallic structures also seem linked but in a secondary form.

The fourth industrial complex includes three primary sectors like other manufacturers, Wood, Cork and its products, and Furniture, which represents the final consumption activity of the complex. The Metallic products are a secondary sector, as the supplier of intermediate products for the manufacture of furniture.

The primary sectors of the fifth industrial complex would be Industrial Machinery, Electrical machinery and Metallic structures. Weak linkages with Primary metal industries and foundries and Electronics reinforce the idea of a complex organized around the industry of machinery and capital equipment.

The sixth industrial complex would be formed by three primary sectors, Textile goods, Apparel, Leather products and Footwear (their differences in economic linkages are not obvious because our data would not allow singling out the structure of footwear manufacturing inputs).

The evidence suggests that Electronics acts in a seventh complexes as a supplier, of inputs for both Office machines, precision instruments, and the Vehicle manufacturing industry. The latter connects at the same time with firms in the Rubber and plastics sector.

The eighth industrial complex captures the interrelations within food products; Dairy products, Drinks and Tobacco products as primary sectors. This complex shows weaker relations with Other food products.

The proposed statistical limits leave out other less intensive buyer-supplier relationships. This is the case of Pharmaceutical industry, one of the most significant cases of a so called "independent industry" since the major part of the intra-industrial trade take places within the sector. Due to these special circumstances, Pharmaceutics is considered here the ninth industrial complex.

Measuring geographic agglomeration: Method

Amongst statistics techniques often used for the study of geographic concentration, we have chosen those developed within the field of spatial econometrics. In short, our analysis begins with the so called global approach that will allow recognition of the spatial distributions of reference (namely, "cluster", "random" or "disperse") using one of the most popular test of spatial autocorrelation, the Moran's I coefficient, which is calculated for each complex in the following form:

$$I = \frac{N}{S_0} \frac{\sum_{ij}^{N} w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{\sum_{i=1}^{N}(x_i - \bar{x})^2} \qquad i \neq j$$

where x_i is the variable (employment) in the region i, $\bar{x}$ is the mean, w_{ij} are the spatial weights in matrix W. In this sense, one pair of municipalities i and j are considered neighbours, as long as they share a frontier –namely, "queen first order contiguity criteria". Finally, S_0 equals $\sum_i \sum_j w_{ij}$.

Due to the incapacity of global analysis to distinguish when the geographic concentration refers to low or to high values of the variable and where the significant local clusters are located, we have refined the global results calculating the so called *LISA measures* or *Local Indicators of Spatial Association* (ANSELIN, 1995). The Local Moran statistics (I_i) is calculated here as:

$$I_i = \frac{z_i}{\sum_i z_i^2 / N} \sum_j w_{ij} z_j$$

where z_i is the normalized value of cluster activity (employment) in the region and I and w_{ij} are the spatial weights in matrix W as above.

In summary, in order to examine the second aspect of the problem, the geographic agglomeration, we take into consideration two types of evidence: the global degree of agglomeration of employment within each complex (Figure 1), as well as the appearance of local clusters of employment from an econometric point of view, as collected in LISA maps (Appendix). To make this feasible it was necessary to adapt the source, *Directory of Units of Economical Activity (Comunidad de Madrid)*, to the activities classification system in the Input-Output framework.

Geographic agglomeration: Findings

The global analysis confirms that all coefficients fall into the region of the test where the null hypothesis of randomness should be rejected and therefore the

alternative hypothesis of (positive) spatial autocorrelation should be accepted. However, a local approach stresses the differences existing in terms of localization and the significance of local clusters across complexes[2].

[Figure 1. Moran I Coefficients of employment in Madrid, 2000]

At the top of the geographic concentration's ranking, we found Pharmaceutics. LISA-maps confirm that the concentration of half the employment occurs within the municipality of Madrid, and the rest throughout the east and north of the metropolis. In fact, many high-tech industries and central offices of service companies are located in the north of the metropolis, sharing an area quality characterised by one of the highest income levels in the region, the presence of human capital, and a special dynamism in the real estate market.

In the second place we found Manufacturers of furniture. Their co-location tendencies could be related to the flourishing of some local product systems as a consequence of the industrial restructuring and decentralisation strategies during the industrial crisis of the eighties. As with other traditional manufacturing sectors, the percentage of employment within the city of Madrid represents only a third. The rest is distributed amongst industrial concentrations elsewhere in the metropolitan area, especially along the main highways. The industrial dynamism of these "corridors" spreads beyond the limits of the region in a "border effect", especially intense at the south and east regional borders.

Machinery and Chemical complexes present a high-medium degree of global concentration. In both cases, along with the concentration of employment

in the central part of the city stand out many large and accessible cities located south and east of the functional metropolitan area that have already attracted important investment during the sixties and seventies.

In the complex around vehicle manufacturing, which presents an intermediate degree of global concentration, different location patterns overlap, beginning with a strong concentration in the central city of multinationals of both auto-makers (*PEUGEOT, RENAULT, NISSAN*…) and automotive components and parts, while the distribution of auxiliary SME networks occur all over the metropolitan region. Previous studies have noted within this group the existence of a *technological district* around Electronics distributed half in the central part of the city and the rest in the east and especially the north area, where the Technological Park of Madrid is located (RAMA, FERGUSON and MELERO, 2003).

The industrial complex of Chemicals shows a medium degree of geographic agglomeration. The employment concentration in the central city of Madrid appears surrounded by several local clusters along the first metropolitan belt. On the other hand, the scarcity of employment identified in the model in the Food products is strongly concentrated in the central city.

At the low concentration level we find three complexes, whereas it is also possible to recognize different overlapping spatial behaviours. Thus, within complex three the location preferences of establishments dedicated to the production of metals and its products are toward the central part of the city as opposed to the sprawled regional distribution of extract industries.

In the same direction, the dispersion of the paper factories coexist with an orientation of printing activities and publishing toward main metropolitan

centres, especially within the city of Madrid, whereas the phenomenon of a concentration of publishing businesses appears locally reinforced by the edition of newspapers and public institutional documents.

Finally, the complex of Textile goods shows the lowest global concentration, with two thirds of the employment in the central part of the city and the rest in some very peripheral locations; coincidentally with disperse manufacturing networks sometimes operating inside an informal economy.

At this point it should be remembered that exposed co-location tendencies among clustered firms does not necessarily mean that such spatial behaviour would be a consequence of existing input-output linkages between them, as indirectly demonstrated by the research carried out by the City Council of Madrid through its Observatory of Local Economy, with a sample of seven-hundred new enterprises created in the city of Madrid since 1998 (AYUNTAMIENTO DE MADRID, 2005).

This survey confirms that the key factors in the location of industrial firms correspond with specific characteristics of employment and premises (first position within a ranking of 32 variables), followed by future accessibility of the establishment (2nd), urban equipments (3rd), proximity to customers (4th), the location of owners´ residences (5th), and personal previous contacts in developing business (6th), which could be interpreted as related to social networks based on trust.

Some of the following factors in the survey reflect, like the five first ones, the existence of different types of economies of agglomeration. In this sense, urbanisation economies would seem to have a higher impact than localisation economies, emphasised in the sample by the lesser importance of the industrial

density of the zone (16th) or a manufacturing tradition (19th). Proximity to suppliers, a potentially significant answer for us, appears however to be relegated to the middle of the ranking (15th), which is consistent with the exposed conclusion of the importance of external orientation of industrial linkages.

In conclusion, as in other agglomerations evidence suggests the importance of common location logic rather than any localised linkages in generating industrial clusters. At the metropolitan-region scale the diagnosis approximates even more closely to the pure agglomeration model, with little evidence for the significance of either industrial complexes or strong social networks (GORDON and MCCANN, 2000; 2003).

FIRM ENTRY TENDENCIES IN SELECTED INDUSTRIAL CLUSTERS IN MADRID

Review of prior mapping initiatives

In response to OECD recommendations, it could be useful to compare our initial cluster identification, based upon the quantitative study of economic and geographic concentration, with previously made mapping initiatives promoted by the Government of Madrid in the sectors of Printing, Pharmaceutics, Aeronautics and Telecommunications, as well as Vehicle manufacturing, Textiles and Furniture. This selection was basically made following political criteria in order to meet the demands of business associations and trade unions. There was no scientific support for this selection.

Following Porter's ideas the Community of Madrid applied a qualitative methodology, based upon interviews, groups of discussion, etc., seeking the definition of policy strategies for all sectors. However, this objective was never reached and even today the institutional interest is limited to those clusters with more economic relevance, which are the focus of the second part of this paper (Table 4).

Despite different date of studies, the selected four provide useful information about possible early resource conditions that catalysed the emergence of industry clusters and also other forms of clustering, beyond the industrial complex model, which has revealed only a partial capacity to explain the origin and growth of Madrid's clusters.

Previous studies about the Printing cluster, that excluded the manufacture of paper and its products, have remarked that during the last century firms have considered Madrid a privileged location due to its large market in terms of concentration of population and client sectors (publicity agencies, big publishing companies, official institutions, etc.). Despite the influence of these economies of agglomeration, the weakness of integration is looked upon as an obstacle for the specialisation and the achievement of an internal economy of scale. The weak integration being substituted by a higher degree of (informal) subcontracting according to firms' capacity, that remembers the non-hierarchical nature of subcontracting networks in some types of industrial districts (COMUNIDAD DE MADRID, 1998a)

The birth of a pharmaceutical cluster in Madrid had originally an active supervision of the State, which declared it of national interest in several economical plans during the past century. Nowadays, in a general context of

business concentration and intense internalisation, the activity in Madrid is lead by some commercial headquarters of the biggest pharmaceutical corporations whose presence in Madrid is primarily guided by factors like accessibility to markets, state-capital conditions or skilled-labour in the context of a global strategy designed in their foreign decision centres. It is only possible to recognise the presence of significant trade inter-industrial links in; a) those cases of big corporations that have decided to translate their production functions elsewhere and signed manufacturing agreements with national laboratories; b) the trade between national laboratories and regional suppliers of chemical inputs, capsules and cases (COMUNIDAD DE MADRID, 2003).

As in many other countries, the consideration of a strategic sector for Defence explains the growth of aeronautic activities under the supervision of the public sector in terms of financial and technological support. Despite the increasingly international level of subcontracting and supplier networks, the intense regional sub-contracting between a few big assembly companies and many SME (and among themselves too) explains that one of the most valued advantages to continue in Madrid is the firms' geographic proximity, that continues playing a determinant role facilitating relationships of industrial, scientific and technical cooperation (ALFONSO, SÁEZ and LACALLE, 2005).

[Table 4: Most relevant previous mapping results in Madrid]

Previous mapping of the Telecommunications cluster included both industrial and service activities, the manufacturing of electronic equipment being the most relevant activity of the former. The origin and evolution of the cluster

has been conditioned by the liberalisation of telecommunication services, forcing *Telefónica*, the former state-run telecommunications monopoly, and the rest of general operators thereafter, to rationalise their purchase of equipment to the detriment of national suppliers. Besides evidence about existing linkages among suppliers and regional producers (especially SME electronic components), there are signs of the proactive behaviour of the community of telecommunication engineers: i.e. start-ups and spin-offs initiated by engineers displaced during the previous crisis phase, or the frequent exchanges of knowledge across companies through networks based on trust and common social values (RAMA, FERGUSON and MELERO, 2003).

Firm entry tendencies

Adapting data from the *Industrial Registry (Comunidad de Madrid)* about new industries[3] created between 1981 and 2005 according to the cluster boundaries described above, it is possible to obtain not only evidence about the cluster differences in terms of firms creation (Table 5), but also about the particular trajectory of each one of them, frequently altered by "environmental jolts" (Figure 2). As emphasised in the literature, while in some cases these shocks could have been overcome via a deep reorganisation process, in others a decline in the number of new competitors announces the beginning of the declining phase of the cluster (POUDER and ST JOHN, 1996). This is something that necessarily should be tested in the different zones of Madrid's metropolis.

[Table 5. Employment in new industries created in the region, 1981-2005]

Since 1981 the Printing cluster has been creating around 580 employees per year in new industries (11.37 % of the total employment in Manufacturing). Such dynamism, higher and more stable during the years than in the rest of the clusters, would be consistent not only with the elevated presence of SME as an initially favourable condition, but also with a detected reduction of barriers to entry as a consequence of new technologies (like pre-printing software or digital printing), encouraging the entrance of new competitors from related business areas (COMUNIDAD DE MADRID, 1998a).

The vibrant business dynamics of the Electronics cluster, which has been registering around 300 employees per year in new industries, could be due to internal factors like the relatively low barriers to entry, some entry-decisions interpreted as exploratory trials for innovation in advanced markets, and high business volatility with a certain cyclical character of entrances (CALLEJON and SEGARRA, 1999). However, the mentioned shifts in the competitive context of the cluster, as well as the change from multi-domestic to global strategies by multinationals seem to have resulted in the delocalisation of some firms and/or the displacement of their production outside the region, along with the reduction of market share of the national manufacturers. This negative trajectory could be a disincentive for the entrance of new competitors into the Electronics cluster in Madrid, where no firms were created in the last year.

Contrary to the two cases mentioned above, Pharmaceutics with close to 60 employees per year in new industries reveals a quite different business dynamic. This cluster shows higher barriers to entry, recently raised as a consequence of several challenges: a broad necessity of investment and a

shorter recovery period as a result of the enlargement of the R&D phase; the need for wider commercial networks in order to gain presence in the principal markets; and the absence of an adequate patent system (COMUNIDAD DE MADRID, 2003). At the same time, the intense internalisation of the sector and the increased presence of multinational companies would also discourage the entrance of new competitors.

The rate of less than 20 employees per year in Aeronautics corresponds with a wide variety of barriers to entry/survival. In assembling big companies, technological and financial barriers, global commercial agreements, and required "know-how". In subcontracting firms immersed in a diversification strategy due to the long product cycles or the existence of a global market, the main barriers, amongst others, are the certification as aeronautic supplier or the requirement for a complete traceability of its products. It is also necessary to mention the impact of the restructuring period during the nineties. The business concentration around the European consortium *EADS* and the increasing internalisation of subcontracting and supplier networks were restraining factors for industrial births in a sector searching in that moment for rationalisation of its productive capacity. Despite the recent uncertainties generated around *AIRBUS*, the intense participation of many of Madrid's subcontracting firms in the A380 project would explain some reactivation at the end of the period.

[Figure 2. New industries created within the industrial clusters of Madrid]

Lastly, in the analysis of geographic patterns of employment in new industries three different situations are recognized:

a) Regardless of cyclical fluctuations observed in the Printing cluster, the central part of the city retains with difficulty a participation in total employment, in contrast to a relative stability of the Functional Metropolitan Area or the steady growth in the rest of the region that at the end of the series concentrates almost 60% of the entire employment. Thus, despite the intense diffusion processes, the city of Madrid would remain a site of innovation acting as an incubator for new firms in the sector, that in many cases have orientated their activity toward products and cultural goods. As occurred in other big European metropolis, like London or Paris, the emergence in Madrid of a cultural industry draws an interesting research field for the future.

b) In Aeronautics the last firm creation within the central city occurred in the mid nineties, confirming the diffusion process initiated decades ago with the translation of some of the main factories of the avionics company CASA to more peripheral zones. In contrast to the previous situation, where the centre maintains a certain prominence, here the nursery function seems definitively translated not only to the Metropolitan Area but also to the rest of the region.

c) The trajectories of Electronics and Pharmaceutics seem to be caused by differences in the business structure on growing poles within each cluster, rather than a genuine geographic movement of an innovation wave.

In the case of Electronics, the decline since the nineties of weight on the central city and the rise of the Metropolitan Area and the rest of the region would correspond more with the dynamism of big national or multinational firms operating at international level and located in peripheral municipalities from the north of the metropolis. As opposed to the vitality of SME microelectronic suppliers, located within the city, more orientated to the local market, and more exposed to changes resulting from the liberalisation of telecommunications.

Similarly, the central part of the city has been sharing its condition as centre of incubation for new Pharmaceutics firms with other sites in the rest of the region. The uneven distribution of both the manufacturing activities, generally located outside the city, and the commercial headquarters, more concentrated within the city, would also be behind these diverging trajectories.

CONCLUSION

The quantitative approach has proved the existence of significant input-output interrelations among co-located industries, at least in nine regional industrial complexes. This is fairly coincident with the prior political selection of the Printing and Pharmaceutics clusters. In the case of Telecommunications, our results suggest the existence of a larger cluster which would also include Electronics and possibly Vehicle manufacturing. Finally, due to the broad scope of the sectored classification of the input-output table, these industrial interconnections cannot be isolated to the Aeronautics sector.

The non-coincident results confirm the presence of some clusters (i.e. chemicals, machinery, and equipment) acting as suppliers for other industries. This is relevant for the internal organisation the economy and contrasts with the political selection, which is limited to some final product-clusters. In this sense, the capacity of extended buyer-supplied value chains approach to reveal both relative strengths and absolute gaps in particular product chains has been already highlighted (FESER and BERGMAN, 2000) .

Furthermore, despite the political focus in knowledge-based industries the results highlight a significant presence of traditional sectors (wood-furniture, textiles and apparel). While the latter have less economic weight, they are contributors to the productive diversification of the metropolis. Moreover they present a high degree of social embeddedness in some local areas of the region. All these aspects point out the need for a wider scope in the cluster development strategies of the Autonomous Government of Madrid.

On the other hand, this study has emphasized the complementary role of the quantitative and qualitative approaches. In this sense, updated case studies in the whole manufacturing sector of Madrid would be needed in order to generalise the conclusions from the qualitative perspective.

Previous mapping studies confirm that besides the initial supporting role of the State, economies of agglomeration would be the strongest incentive for firms clustering. Even though this motivation seems fairly maintained along each cluster evolution, in the particular case of Electronics it is necessary to also refer to milieu effects, while in Aeronautics the results confirm the importance of the industrial linkages as suggested by the industrial complex model.

The exploratory analysis of new firms' creation has revealed that in the four selected industrial clusters, coexist quite different environmental conditions for the entrance and survival of new competitors. Along with some decisive changes in the competitive context of clusters affecting their recent dynamism, there have also been detected certain displacements of the nursery function from the central part of the city to more peripheral locations.

Taking into consideration the integral vision of the development of the clusters in metropolitan regions (VAN DEN BERG, BRAUN and VAN WIDEN, 2001), all these aspects could help to adapt policies according to different sectors and territories of Madrid. This process would allow for prioritizing measures to be taken, such as entrepreneurial promotion, backup for start-ups, better use of existing resources, fostering of cooperation networks, or enhancement of social-institutional support.

In summary, a scientifically-based method for cluster mapping and a deeper understanding of the singularities in the growth processes of industrial clusters could prove a useful tool for the authorities of Madrid to revitalize cluster development policies.

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APPENDIX: LISA MAPS OF MADRID'S INDUSTRIAL-COMPLEXES, 2000

[APPENDIX: LISA MAPS OF MADRID'S INDUSTRIAL-COMPLEXES, 2000]

Table 1. Industrial clusters: a transactions costs perspective

Characteristics	Pure agglomeration	Industrial complex	Social network
Firm size	Atomistic	Some firms are large	Variable
Characteristics of relations	Non-identifiable Fragmented Unstable frequent trading	Identifiable Stable and frequent trading	Trust Loyalty Joint lobbying Non-opportunistic
Membership	Open	Closed	Partially open
Access to cluster	Rental payments Location necessary	Internal investment Location necessary	History Experience Location necessary but not sufficient
Space outcomes	Rent appreciation	No effect on rents	Partial rental capitalisation
Example of cluster	Competitive urban economy	Steel or chemicals production complex	New industrial areas
Analytical approaches	Models of pure agglomeration	Location-production theory Input–output analysis	Social network theory
Notion of space	Urban	Local or regional but not urban	Local or regional but not urban

Source: IAMMARINO and MCCANN (2006)

Table 2. Factor Analysis Total Variance Explained

Initial Eigenvalues (>1)			
Component	Total	% of Variance	Cumulative %
1	5,91	19,06	19,06
2	3,68	11,86	30,92
3	3,29	10,62	41,54
4	2,94	9,48	51,03
5	2,89	9,32	60,34
6	2,18	7,05	67,39
7	1,84	5,93	73,32
8	1,32	4,27	77,58
9	1,08	3,49	81,08
10	1,03	3,33	84,41

Source: Author's data.

Table 3. Identified industrial complexes

No	Sectoral composition
1	- Publishing products - Paper and its products - Glass products - Printing products
2	- Basic chemicals - Other chemical products - Other food products - Industrial chemical products
3	- Extractive industry of non energetic minerals - Other no metallic industries products - Primary metal industries and foundries - Other transportation material * - Metallic structures *
4	- Other manufactures - Wood, cork and its products - Furniture - Metallic products *
5	- Industrial Machinery - Electrical machinery and apparatus - Metallic structures
6	- Textiles - Apparel - Leather products and footwear
7	- Office machines and precision-optical instruments - Electronics - Motor vehicle manufacturing - Rubber and plastics
8	- Dairy products - Drinks and Tobacco products
9	- Pharmaceuticals
(*) Secondary sectors within the industrial complex	

Source: Author's data.

Table 4: Previous cluster mapping results in Madrid.

CLUSTER OF PRINTING - Big offset printing presses orientated to magazines, commercial pamphlets and books. Smaller firms orientated to stationery and other products - Big companies dedicated to pre-press activities, packing firms or post-press - Publishing companies, including textbook leaders in the country - Others actors: Distributors, libraries, publicity agencies, business associations, etc.
CLUSTER OF PHARMACEUTICS - Commercial headquarters of the biggest corporations, dedicating to commercial, prices decision and R&D - Laboratories of medium-sized multinationals in commercial activities and clinical tests - National laboratories (Diversified production: patented pharmaceuticals, “generics”, cosmetics…) - Suppliers of chemical inputs, capsules and cases - Others actors: Clinical Research Organizations, Universities, distributors, pharmacies, etc.
AERONAUTIC CLUSTER - Final assembly big companies with financial and technological capacity to integrate aircrafts Firms competing internationally and specializing in design and R&D of specific components, equipments and systems - Medium-size manufacturers under specifications - SME networks subcontracted by assembly companies (electronics, mechanics, welding) - Others actors: Business associations, Public Administrations, etc.

CLUSTER OF TELECOMUNICATIONS / ELECTRONICS

- Manufacturers of equipment (i.e. communication systems, Internet, cable-TV, etc.) some competing internationally but without direct manufacturing function in Madrid
- SME suppliers of electronic components
- General operators, providers of added value telecommunication services
- Others actors: Business associations, public supporting institutions, etc.

Source: Adapted from COMUNIDAD DE MADRID (1998a, 1998b, 2003), ALFONSO et al. (2005) and RAMA, FERGUSON and MELERO (2003).

Table 5. Employment in new industries created in the region, 1981-2005

NACE	Cluster	Annual average (employees)	Average of percentage over Manufacturing	Max. average percentage	Min. average percentage
222	Printing	574.08	11.37 %	20.50 %	3.15 %
32	Electronics	304.28	4.95 %	15.98 %	0 %
244	Pharmaceuticals	62.68	0.91 %	7.90 %	0 %
353	Aeronautics	18.96	0.37 %	2.97 %	0 %

Source: Registro Industrial (Comunidad de Madrid).

Figure 1. Moran I Coefficients of employment in Madrid, 2000

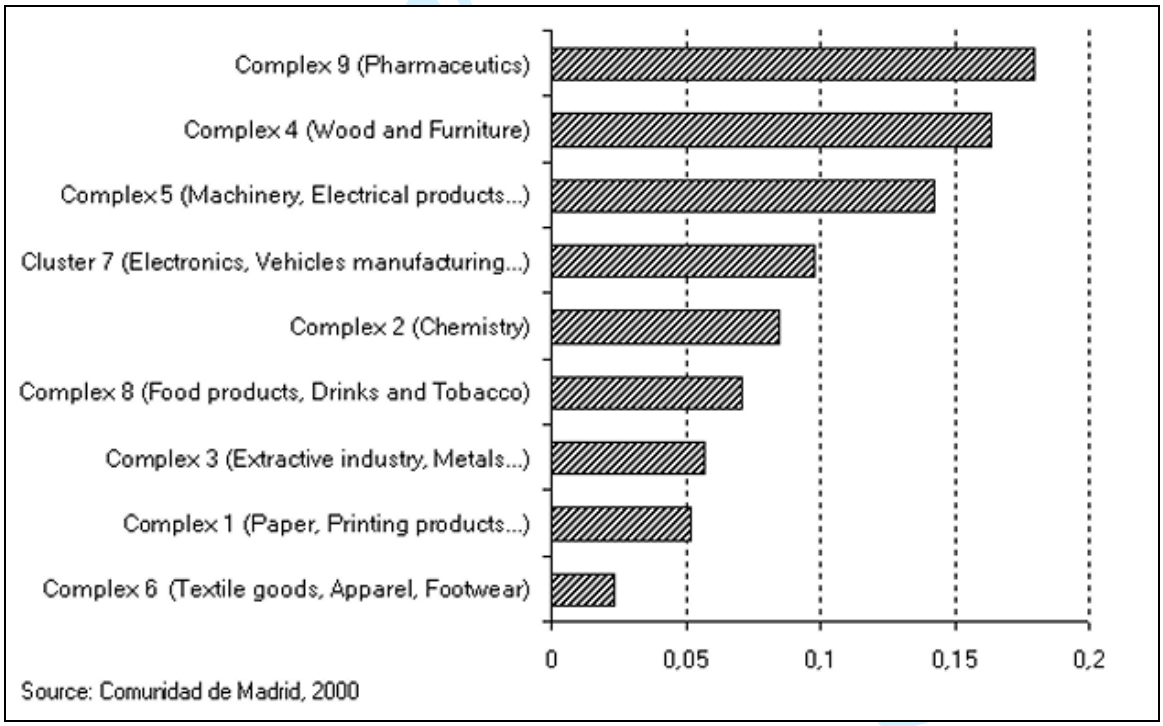
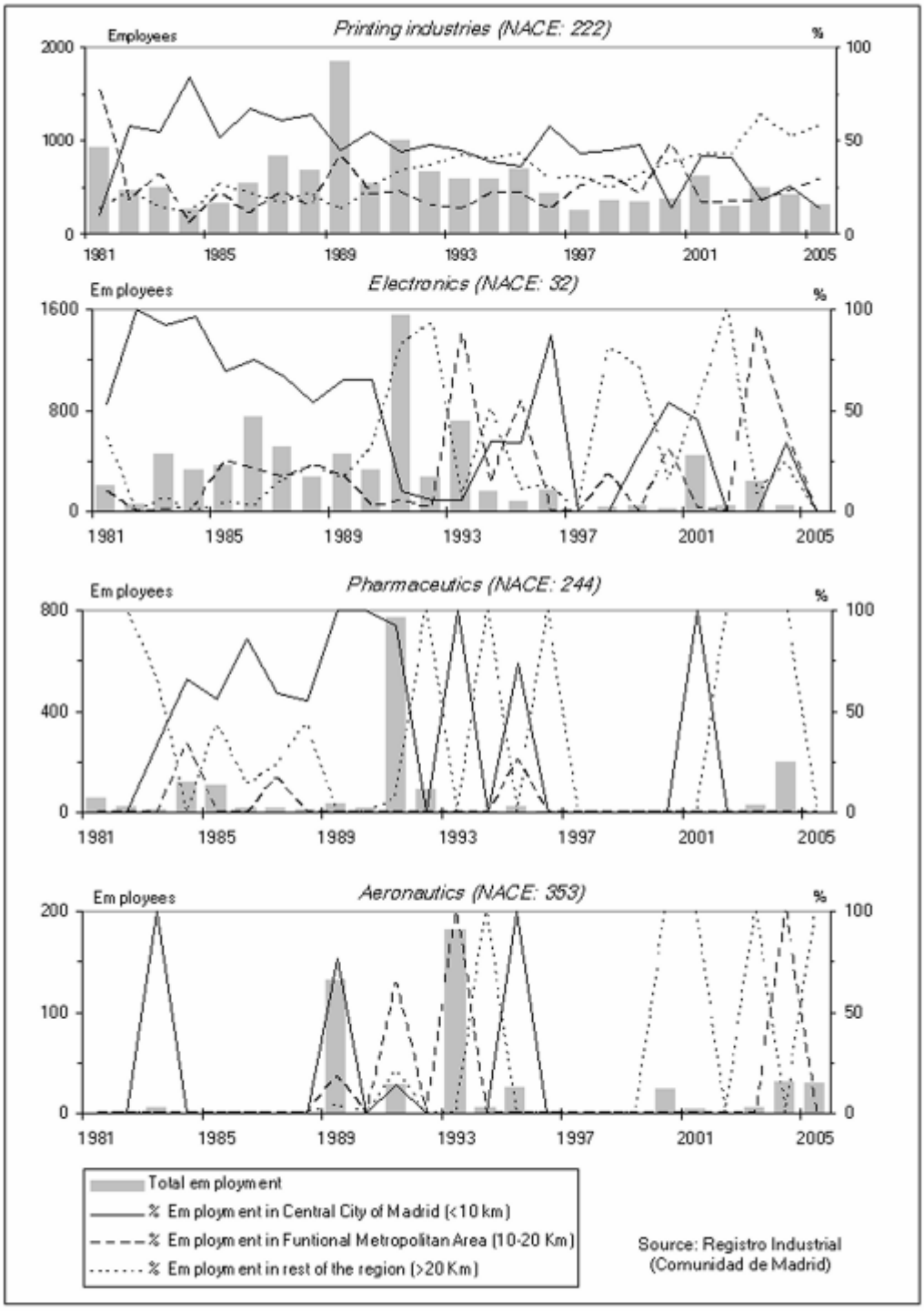
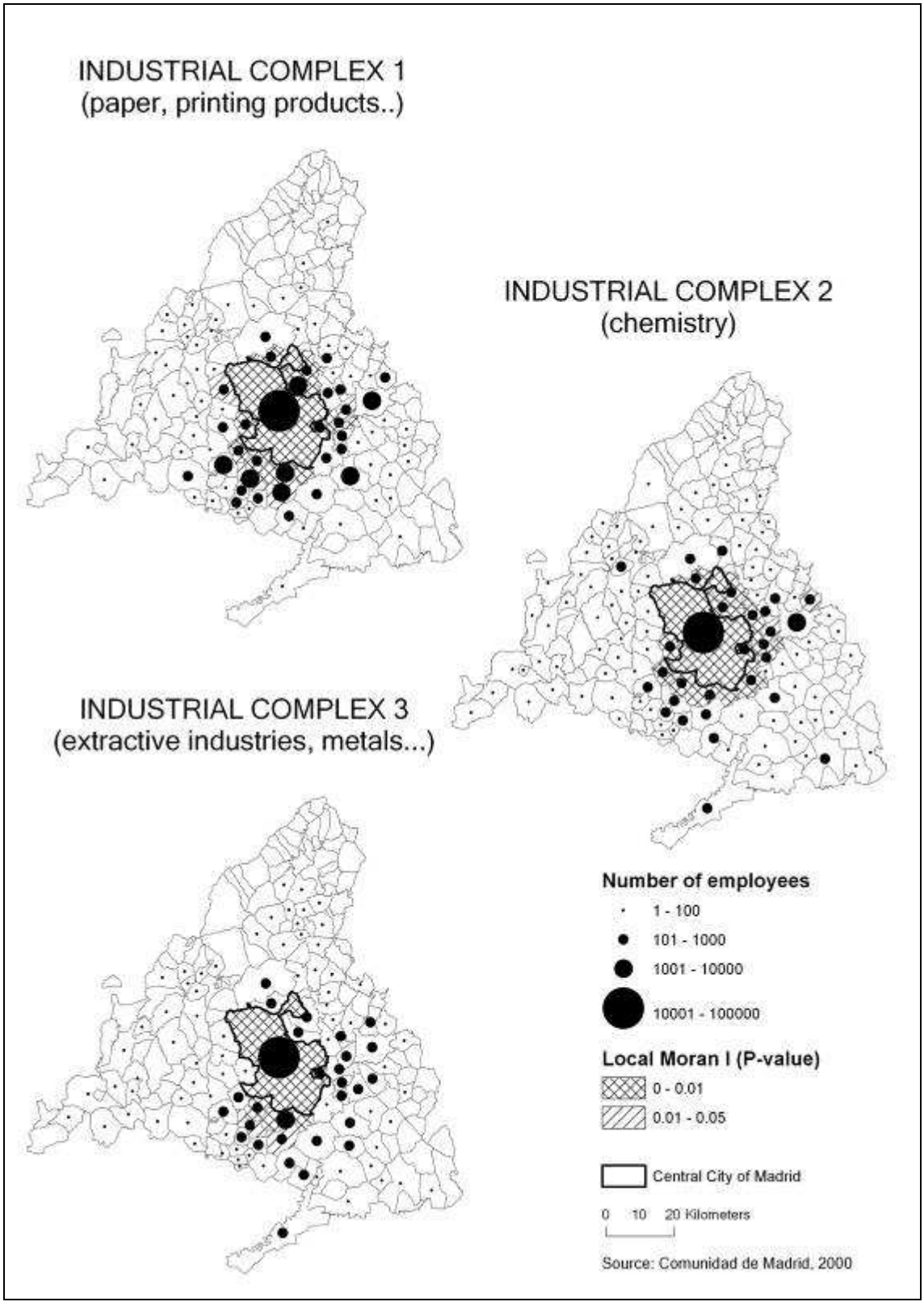


Figure 2. New industries created within the industrial clusters of Madrid



APPENDIX: LISA MAPS OF MADRID'S INDUSTRIAL-COMPLEXES, 2000



APPENDIX: LISA MAPS OF MADRID'S INDUSTRIAL-COMPLEXES, 2000

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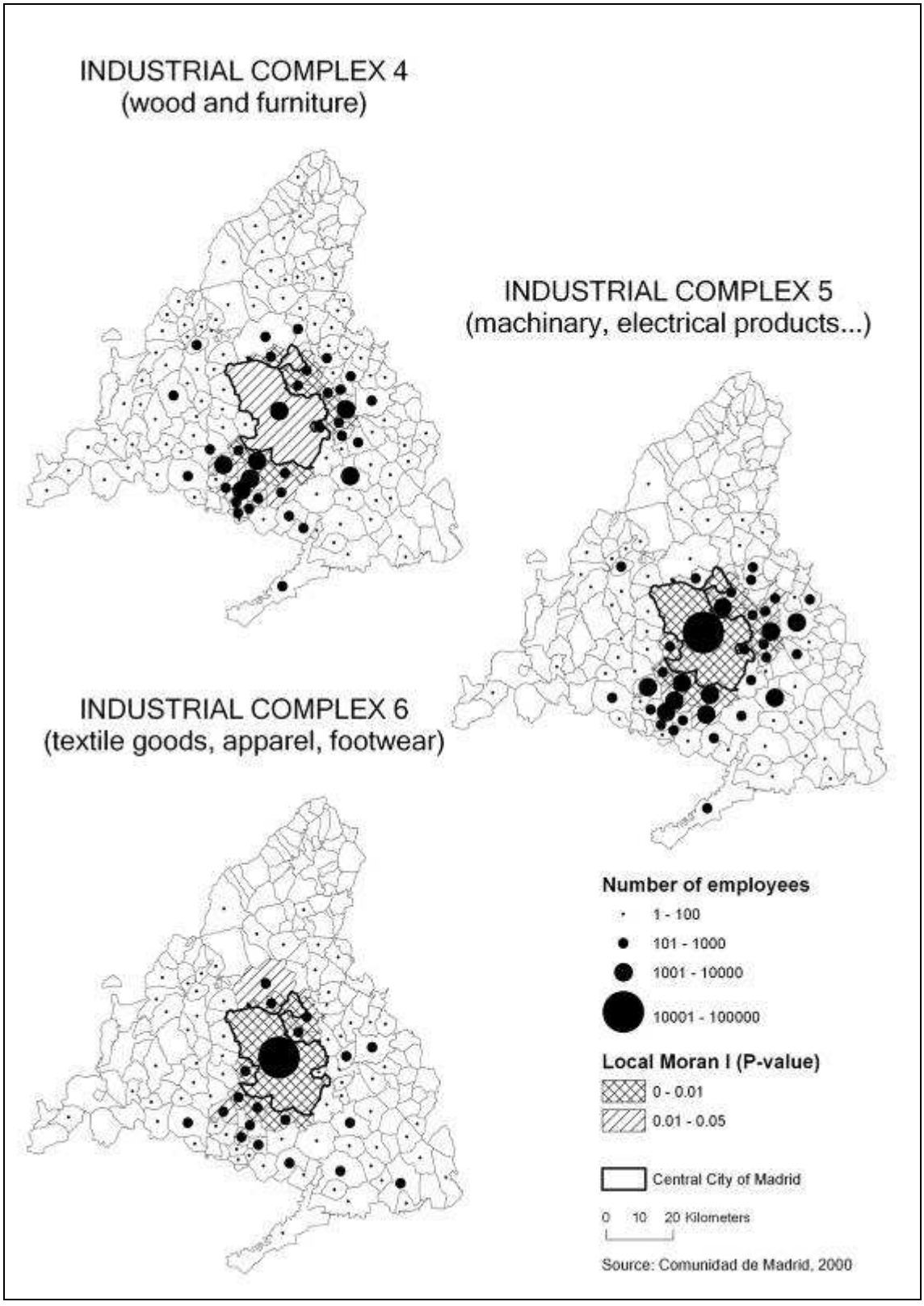

APPENDIX: LISA MAPS OF MADRID'S INDUSTRIAL-COMPLEXES, 2000

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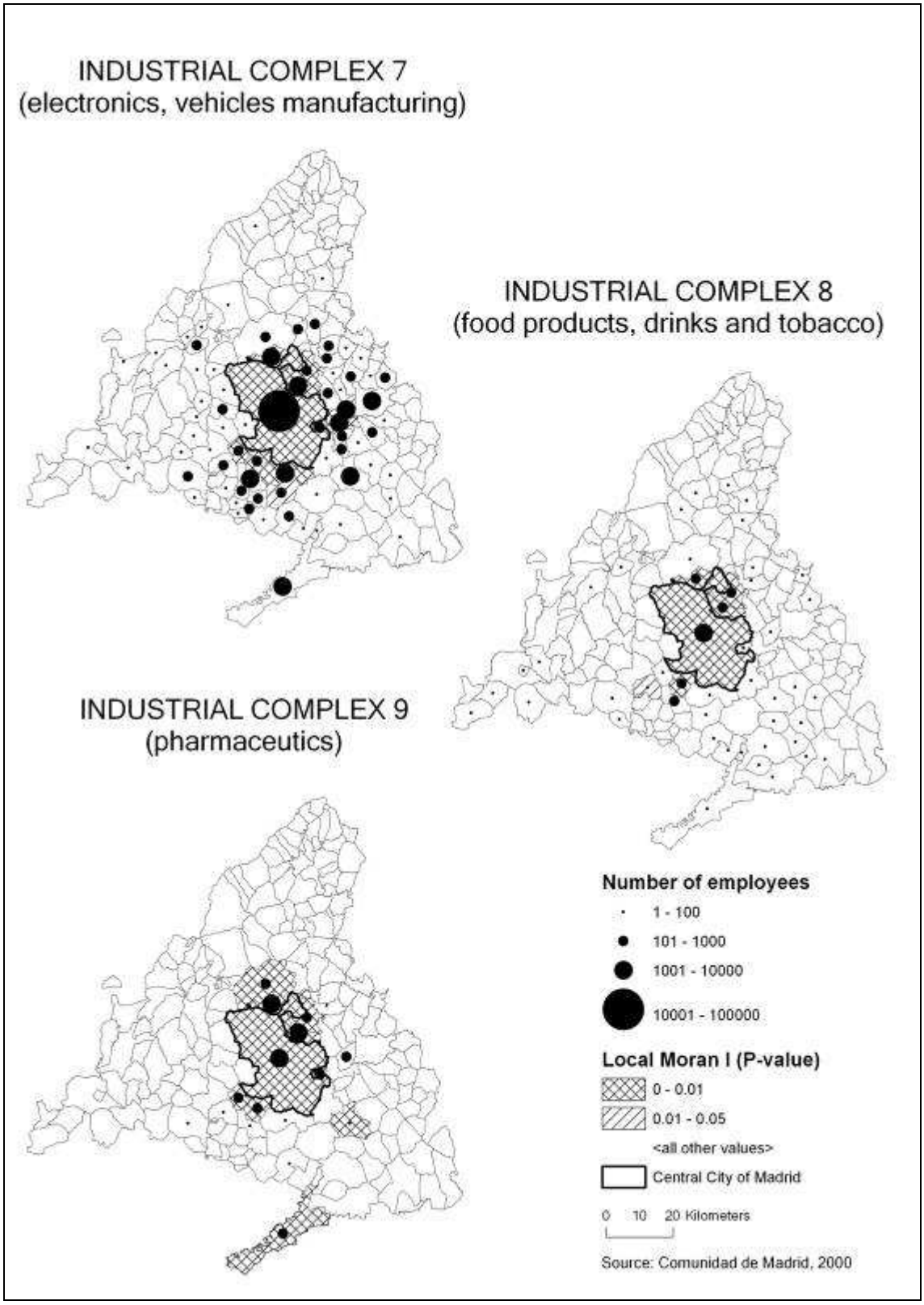


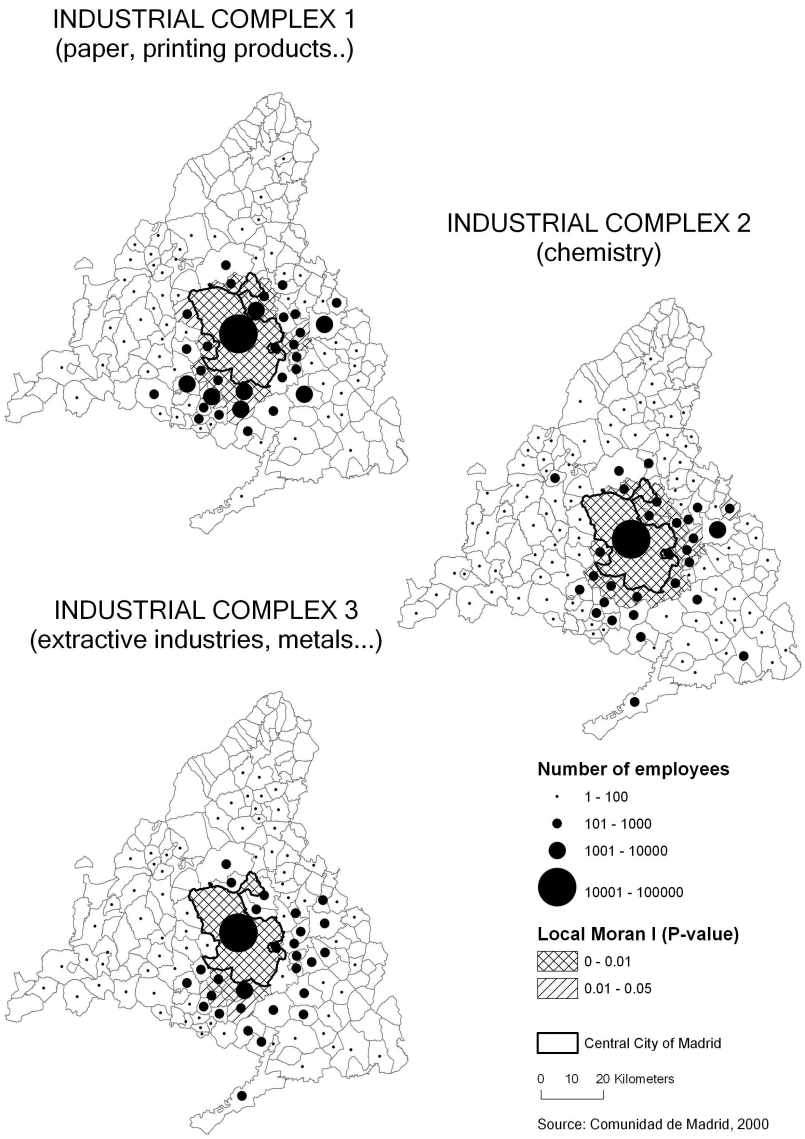
NOTES

[1] The set of complexes considers both primary sectors (correlation coefficients in the rotate components matrix >0.60) and secondary sectors (between 0.35 and 0.60). Secondary sectors that have punctuation below 0.60 but higher coefficients in any other component are also considered.

[2] Interpretation of pseudo-significant Moran I coefficients (random permutation approach):

- If I>-1/(n-1): positive spatial autocorrelation or spatial cluster of high and/or low values
- If I<-1/(n-1): negative spatial autocorrelation or spatial cluster of high and low values.

[3] The only available source of information that provides data related to the creation of new firms at local level is the Industrial Registry of the Comunidad de Madrid. However, the information in the registry relates to the creation of "new industries" instead of "new firms". The term "new industries" is used to describe new establishments or plants opened by a manufacturing firm. Nevertheless, we have used the variable "new industries" as an approximation to measure the new firm creation process.



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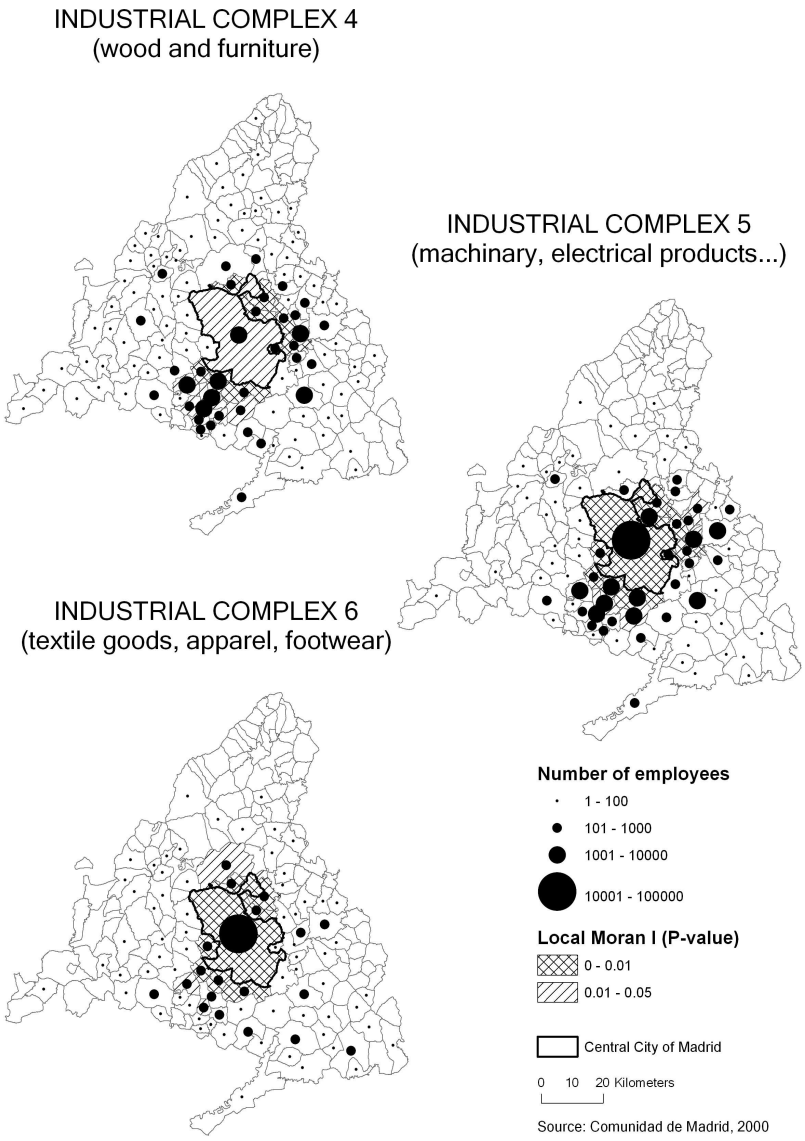

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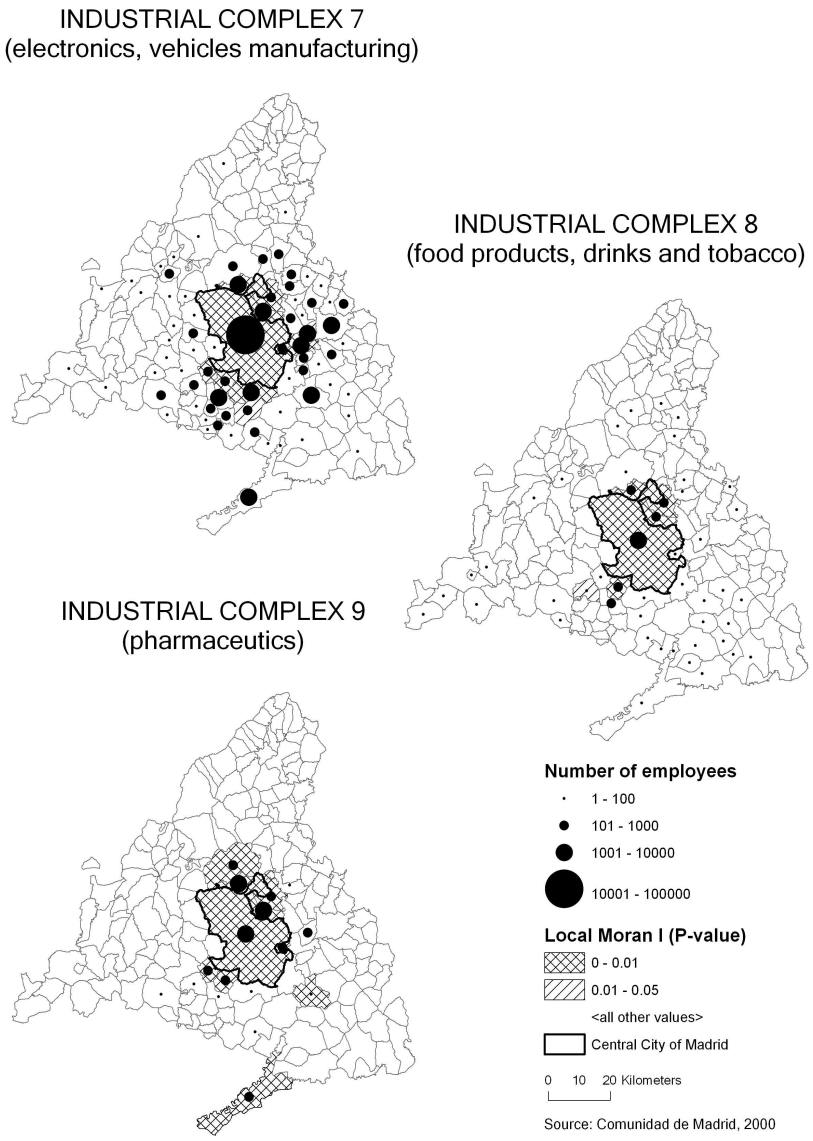

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