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Clusters of Cultural and Creative Industries: Empirical Evidence for Catalonia

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Abstract

Creative clusters are increasingly being recognized as vital tools in the promotion of a city's competitiveness, innovation, urban development, and growth in developed countries. This paper studies the geography of Cultural and Creative Industries (CCIs) in Barcelona (Spain) for the years 2009 and 2017. We investigate the spatial distribution of firms using the Scan methodology, which identifies the localization of clusters and assigns them statistical significance. Our findings indicate that CCIs are not haphazardly located, as they tend to cluster in and around Barcelona's prime districts. The evolution of the clusters over nine years reveals distinct patterns of clustering among the twelve sub-sectors of CCIs. The mature clusters in Barcelona's core tend toward greater growth and have enhanced transformation capabilities. Our results can guide CCIs cluster policy, taking into account the specificity of each sub-sector. In addition, they can direct place-based development strategies and creative urban planning and restructuring within a polycentric context.

Keywords: creative industries, clusters, scan statistics, Barcelona.

JEL codes: C38, Z10

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1.Introduction

Given the recent focus on the importance of Cultural and Creative Industries (CCIs) clusters, understanding the detailed dynamics of firms located in these clusters is essential. While many previous studies have been concerned with CCIs agglomeration in general terms, we specifically look into significant clustering and its urban evolution of over a period of time. This paper therefore addresses the current emphasis on smart specialization tools for economic transformation and policymakers' initiatives (mainly in the EU and OECD countries) to successfully tap the regional potential of creative clusters "as a way to promote socio-economic development, including the use of EU Structural Funds" (European Commission, 2012, p. 3). Concretely, we aim to provide an improved understanding of CCIs clusters in the Functional Urban Area (FUA) of Barcelona.

Research in the area of spatial distribution of economic activities begins by identifying certain spatial patterns in order to provide a range of rationalizations about their determinants or implications. CCIs have important direct, indirect, and induced roles in the economy, ranging from stimulating innovation (Jones et al., 2016), boosting GDP growth (De-Miguel-Molina et al., 2012), and catalysing urban economic expansion (Cunningham, 2010). They also play a role in endorsing economic resilience through fostering efficiency and stability in times of economic uncertainty (Mitkus and Maditinos, 2017), mainly because these industries depend on local knowledge and are quite place-specific (Comunian and England, 2018). But literature about CCIs has unclear boundaries since their standard classification has only recently been provided (DCMS, 1998) and followed up with the policy-making definitions of cultural employment and occupations (Eurostat, 2018): *creative economy* (OECD, 2007), *creative class* (Florida, 2002), *creative cities* (UNESCO, 2012) and, more recently, *creative clusters* (Lazzeretti et al., 2012; Boix et al., 2012; Mommaas, 2004). The latter is the focus of this study.

Boix et al. (2012) consider that the geography of creative industries is *diverse*, *heterogeneous,* and *complex*. Understanding creative clusters is fundamental for the design and implementation of policy-making (Boix et al., 2012) and entry strategies for creative firms. Therefore, CCIs are of noticeable importance in economic terms, and they tend to cluster in a different way than other industries. In the last decade, there has been a growing realization that CCIs, such as music, fashion, publishing, film, media, research and development, and software design, are significant economic contributors to developed countries in terms of innovation, local development, and employment growth (OECD, 2018). There has been increased attention to developing and sustaining the cluster approach in these countries, mainly through the use of smart specialization strategies as tools for regional and local development. This has been made evident by the recent initiatives carried out by the European Commission and the OECD to foster better innovation strategies based on clustering patterns and smart specialization, with the aim of creating new economically productive and innovative urban locations. Due to the growth of the creative economy in major European cities ranging from fashion and design to software and innovative research and the challenges confronting urban policy on supporting these industries, economic geographers have been called on to address the formation, growth, and decline of creative clusters.

With CCIs cluster planning, CCIs are moving more to the forefront in policy-making agendas. The objective of this paper is to contribute to this area of research, focusing on the FUA of Barcelona as a major European hub where CCIs play an important role in positive economic and social externalities. We aim to interpret the spatial distribution of cultural and creative firms and uncover their clustering patterns, both in general terms (for all the CCIs) and at the industry level, using geo-located firm data from the SABI database (Mercantile Register). This study is exploratory in nature, and we answer the following research questions by proposing the application of an innovative methodology, SaTScan (Software for spatial, temporal, and space-time scan statistics): Do cultural and creative industries cluster in the core or in the periphery of the FUA of Barcelona? And if any preference exists, is it shared by all sectors or are there different spatial patterns? Do these patterns evolve over time? Is there a specific urban resilience encouraging core CCIs clusters given the characteristics of cluster lifecycles and urban amenities?

The structure of this paper is the following. The second section reviews the literature and addresses the main points raised by scholars on cultural and creative industries, their spatial distribution and clustering patterns. The third section details the characteristics of the dataset and the methodology used to identify clusters. The fourth section discusses the main results. Finally, the fifth section concludes and indicates directions of further analyses.

2. Spatial Distribution of Cultural and Creative Firms

2.1 Clusters and Competitive Advantage

Recent literature has emphasized the importance of clustering and its ability to generate numerous gains for firms, cities, and rural/periphery areas by encouraging the regeneration of underprivileged localities, enhancing productivity and competitiveness, stimulating entrepreneurship, boosting economic growth through employment, and innovation, among other positive knowledge spillover effects (Boix et al., 2012; Porter, 2008; Mommaas, 2004). This makes the concept of creative cluster development vital within economic strategies for local and regional development in EU countries and other developed nations. Principally, the chief argument is that creative industries are spatially concentrated (Boix et al., 2012; De Vaan et al., 2012; Lazeretti et al., 2008).

2.2 Creative Clusters: Geographical Locations and Related Determinants

The literature in the field of firm spatial distribution, clustering, and location patterns has expanded considerably in recent years, emphasizing the notion that "place" matters. Within this strand, analyses about CCIs have also grown considerably (given their social and economic weight in developed economies), using a wide range of methods and geographical contents.

Among the contributions using qualitative research, we highlight Asheim et al. (2017) about the New Media Cluster (Sweden / Norway); Martins (2016) about the role of urban design in the development of creative production in Shoreditch (East London); Dyba et al. (2019) about a furniture clustering comparison between Italy and Poland; Lin (2017) about the design and music industry cluster in Taipei; and Kiroff (2017), who examined the spatial distribution of firms in three creative design subsectors (architecture, specialized design, and advertising) in Auckland (New Zealand). Among quantitative approaches, there are those by Polèse et al. (2007), on the location of economic activity in Spain focusing on the role of distance to metropolitan areas and city size; Coll-Martínez et al. (2019), using firm-level geo-located data to calculate distance-based *M* and *m* functions of CI agglomeration and co-agglomeration in the metropolitan area of Barcelona; and Méndez-Ortega and Arauzo-Carod (2019), using the Nearest Neighbor Index (NNI), *M*-functions and local spatial autocorrelation indicators to analyze the location patterns of software, videogames, and electronic editing firms in the Metropolitan Area of Barcelona. In a larger, European urban context, Boix et al. (2015) avoid the limitations of methodologies allocated to administrative data by using geo-referenced micro-data and a nearest neighbor hierarchical clustering algorithm (NNHC).

Following previous contributions, this paper fills the gap in terms of lack of spatially disaggregated analyses of clusters in CCIs at the sub-industry level, applying innovative methodology and using geo-referenced micro-data to identify statistically significant clusters. The usage of spatial scan statistics applied to CCIs clusters is novel and has only recently been applied to other industries (e.g., Lopez and Páez, 2017). In spite of the advantages of the preceding approaches, this method uniquely admits the identification of statistically significant clusters, Most-Likely Cluster (MLC), and secondary clusters, which provides a clearer picture of the clustering of economic activity instead of just identifying clusters in a binary way (i.e., clustered vs. non-clustered areas). Although this approach is similar to

Boix (2015), we exploit the capabilities of Scan methodology to detect significant industrial clusters and identify their spatial boundaries. The major advantage of Scan methodology is that the reference used is not the distance between firms in CCIs, but rather the geographic concentration of CCIs firms in a specific location or area.

Why firms in the creative industry do cluster is a question that has been asked by a number of researchers in different countries and various scopes of analysis. Creative industries are varied in their nature, and they cluster and prosper in response to the distinctive knowledge bases and characteristics of each community (Wu, 2005). On a general note, the common determinants in the formation of clusters, as derived from the literature, are the following:

1. Cultural heritage including historical place, monuments, ruins (Lazzeretti et al., 2012; Cooke and Lazzeretti, 2008; Mommaas, 2004)
2. Universities and knowledge transfer (Wu, 2005)
3. Localization externalities (Lazzeretti et al., 2012)
4. Urbanization economies (Gong and Hassink, 2017; Lorenzen and Frederikson, 2008)
5. Creative Class (Florida, 2002)
6. Spin-off dynamics (Gong and Hassink, 2017)
7. Public intervention and supporting institutional *milieu* (Foord, 2009); governmental regulation in the form of local, regional, and national frameworks which affect spatial patterns of creative firms (Wu, 2005; Turok, 2003)

The complementary needs of interrelated sectors within CCIs along with the benefits from technological spillovers are factors that facilitate the long–term growth of creative clusters in certain areas and encourage their stability and innovative capacity (De Propris et al., 2009). Many of the findings in the literature link cultural and creative clusters to urban areas. The concentration is most common in big cities, leading to the formation of hubs. By ranking, the most visible creative clusters are formed in London, Paris, Madrid, Milan, Barcelona, and Rome, with differences in concentration levels among the cities, while medium-sized cities also feature some form of concentration of local creative systems (Boix et al., 2012). Hutton (2004) finds that creative clusters concentrate in inner city areas because of the innovative *milieu* that the city provides, in addition to the cultural heritage, parks, and tourist attractions that make the core of cities very attractive. Recently, this notion has been challenged. Some researchers have started to address the "suburbanization" of creative clusters as suburbs are shifting from pure residential areas to culturally and economically intricate and active ones. Bain (2016) argues that creative clusters are also flourishing outside the core of cities, and these areas are no longer necessarily "uncreative zones".

In a detailed contribution to the economic geography of creative industries, Gong and Hassink (2017) present a systematic literature review of the role of agglomeration economies in CCIs. In terms of the role played by cities, large ones commonly provide urban amenities that are attractive to the creative class (Florida, 2002), whilst Lazzeretti et al. (2012) find a significant impact of urbanization economies on the clustering of CCIs in Spain, and a less important effect in the Italian context.

Gong and Hassink (2017) also discuss the role of "spin-off" activities, which we can interpret as by-products and by-services resulting from universities and parent companies. Examples can be seen in knowledge transferring among personal networks and employees of creative firms (De Vaan et al., 2012), university research centers (software design companies near universities with active computer science engineering faculty), as well as corporate subsidiaries agglomerating near parent firms. Wu (2005) presents other examples of how academia and local creative firms can interrelate: *i)* Boston's Research Row (MIT, Harvard, and other local universities) playing a role in the growing concentration of start-ups and R&D firms providing cutting-edge research and innovative solutions for many consumer problems throughout the world; and *ii)* fashion clusters in New York, where he found considerable local impact on university-based innovation and entrepreneurship in the city.

Predictably, a third core factor that influences the location decisions of creative firms are institutions and urban, regional, and local policies (Gong and Hassink, 2017). This is an argument previously validated by Turok (2003), who emphasizes the role of institutions in the development of creative clusters, arguing that it is not a story of localized networks or clusters of small knowledge-intensive firms generating regional growth through an endogenous process, contrary to the image conveyed by policy-makers and advisers. Similarly, Foord (2008) investigates the cases of Barcelona, Berlin, and London and finds that public and private institutions play an important role in developing creative clusters.

Another branch of the literature that should not be left out is that dealing with cluster *building*. Based on three case studies in Sweden (music, information and content design, and film), Power and Hellencreutz (2005) outline major common factors essential for building clusters. The first one is the existence of a regional competitive advantage, not necessarily starting from a large agglomeration of firms (an argument in line with the findings by Lazzeretti et al. (2012) in the case of creative clusters in Italy). The second one is the intervention of the public sector in financing educational programs and vocational training and infrastructure to stimulate clusters; particularly focusing on place-marketing and cluster-branding in order to better attract investments, public funding, and entrepreneurs. The third one is the existence of places, such as temporary sites and festivals, or permanent ones, such as universities, to provide meeting places where knowledge can be exchanged in addition to creating entertaining social contexts and a better quality of life to attract creative people.

On a final note, creative clusters differ in their spatial patterns in the same way that CCIs differ from other industries in their structure and characteristics (Mommaas, 2004). The differences could be in their orientation from productive creative firms to consumption-leading creative firms, their financing, spatial position within wider urban infrastructures, and policy intervention strategic plans. Different cluster and location tendencies for different sectors of creative and cultural industries can also result from the different stages of the CCIs value chain. While production and manufacturing activities are the most regionally concentrated, consumer/end-user-oriented activities are the least regionally concentrated (Europe INNOVA, 2011). Clustering is evident among creative firms specialized in manufacturing or publishing (games publishing, recorded media and film and television activities, software and music publishing, news agencies, and musical instrument manufacturing), as well as institutions related to cultural heritage. Thus, it is essential to consider the specificity, interconnections between different drivers, external linkages among creative firms, and comparisons between different locations of each creative sector to better understand and explain the clustering of creative firms.

To sum up, CCIs have been identified as major actors in the economic growth of urban areas where these industries tend to cluster. Unfortunately, less is known about the way in which specific CCIs cluster and their preferences for locating in the core or the periphery of these urban areas, which is precisely the main aim of this paper. Nevertheless, as we want to focus on cluster identification, the econometric analysis of cluster determinants has been left for future research.

3. Data and Methodology

3.1 Data

The source of the data is the SABI database (acronym for Iberian Balance Analysis System) that collects economic information on an extensive list of businesses in Spain. SABI collects data from the Spanish Mercantile Registry, where firms are obliged to deposit their balance sheets on an annual basis[1]. SABI is not a census and coverage is uneven for different Spanish regions, but approximately 40% of all Spanish businesses are listed in this data bank. The biggest advantage SABI has is that individual firms are geo-referenced at their latitudinal and longitudinal coordinates. Our dataset covers the number of firms in the Functional Urban Area (FUA) of Barcelona. In this paper we include two years, 2009 and 2017. The first one is just after the economic downturn (2007) that pushed thousands of firms out of markets, whilst the second one, belongs to the beginning of the economic recovery, although the number of firms was still lower than at the beginning of the period: 130,313 total firms were located in FUA in 2009, among which 10,635 are firms in the cultural and creative industries (8.16%), compared to 98,422 total firms located in the same area in 2017, among which 8,775 belong to CCIs (8.94%).

3.2 CCIs Industries

Providing a definition for cultural and creative industries is not an end in itself for this paper, nonetheless, it is necessary to first define the sectors involved. Following previous studies (see, among others, Lazzeretti et al., 2008; Lazzeretti, 2013,), we build on the prevalent definition of the twelve CCIs subgroups: Advertising; Architecture and Engineering (hereafter Architecture); Cinema, Music, TV and Radio (hereafter Audio-Visual); Fashion; Graphic Arts and Printing (hereafter Graphic); Jewellery, Musical Instruments and Toys (hereafter Jewellery); Photography; Publishing; Research and Development (hereafter R+D); Software and Video-games (hereafter Software); Writing, Performing Arts, Visual Art and Crafts (hereafter Arts); and Activities Related to Heritage (hereafter Heritage). Details on CCIs along with their CNAE 2009 and CNAE 93 equivalence (adapted from the Spanish Statistical Office) are presented in Appendix 1.

3.3 Area under Study: Functional Urban Area of Barcelona

[1] SABI is the most common database to analyze firms' location distribution for the Spanish case, although it has some limitations, such as size coverage (i.e., it focuses mainly on medium-sized and large firms) and the profile of firms (i.e., it is about firms, not about firms' establishments).

The area under study in this paper is the Functional Urban Area (FUA) of Barcelona (Spain). This FUA has a resident population of 4,991,133 inhabitants (2018), with the municipality of Barcelona totalling around 1.5 million inhabitants. The economic activity rate in Barcelona FUA was 59.51% in 2019, and the ratio of the employed to economically active population was 89.09% for the same year. Barcelona city, the core of the FUA, is the second largest city in Spain and is a major cultural center for heritage, music, architecture, design and, recently, innovation. According to its size, attractiveness, specialization in CCIs, and economic importance in general terms, the city of Barcelona can be considered the core of the FUA, and the rest of the 134 municipalities, are its periphery. Nevertheless, i) as some CCIs have suburbanized in recent years, this core-periphery distinction only holds true when discussing CCIs as a whole, and ii) inside Barcelona, is it also possible to identify specific areas acting as cores for specific CCIs.

[Insert Figure 1 Here]

In this research, the unit of analysis is the census track[2]. The FUA of Barcelona is divided into 3,050 census tracks and using SIG software, the total number of firms in each census track is calculated, as well as the number of firms in CCIs. Figure 1 shows the spatial distribution of all the firms (aggregated by census track) in the FUA. Each point in the figure is the centroid of a census track. The centroids of census tracks are used to identify the clusters.

3.4 Cluster Identification: Methodology of the Scan-test

There has been a large amount of research in recent years into statistical methods for identifying localized clustering. The Scan-test (Kulldorff, 1997) is probably the most frequently used test in epidemiology to identify clusters of diseases, but it has

[2] Census track (CT), *"Secciones Censales*", represents the smallest territorial unit for which population data are available in Spain. The number of inhabitants of each CT ranges from between 1,000 and 2,500 inhabitants. We consider this spatial unit as a reference to identify spatial clusters. Latitudinal and longitudinal coordinates (centroids) were assigned to each CT and the distance between two CTs was defined as the distance between centroids.

been used in many other areas aiming to identify firm clusters (Kang, 2010; López and Páez, 2017; Murray et al., 2014; Chasco et al.., 2020). Additionally, there are other specific approaches used to identify CCIs clusters, such as those by Boix et al. (2015), using nearest neighbor methods and Lazzeretti et al. (2008), using location quotients.

For our propose, we consider that the Scan-test methodology is relevant for three reasons. In the first place, the Scan-test evaluates the null hypothesis of independence. In the second place, if the null is rejected, the test gives valuable information, geographically identifying the area with a differential and quantifying said differential. Lastly, the test can geographically identify one, or perhaps multiple, non-overlapping clusters with high/low levels of CCIs. The final output of the test is both a statistic value with a level of significance for each cluster and a map showing where the clusters are located. This map can to help to confirm or refute the hypothesis about why the clusters are located in those specific areas and not in others.

The procedure of the Scan-test consists of imposing a set of windows on a map and moving their centers over each point location until each window includes different sets of neighboring points at different positions. By adjusting the central location and its shape, this test generates a large number of differing windows, each one with a different set of neighboring points. At each point location, the size of the window continuously increases from '0' to a user-defined maximum size (lower than 50% of the total population[3]). The Scan-test looks for the windows where there is a maximum difference between inside and outside the window. In the case of our research, the null hypothesis is that in all locations (i.e., census tracks in Barcelona FUA), the probability of finding a CCIs firm is the same, whilst

[3] We decided to use a smaller threshold (10% of the population) in our research. This tuning parameter must be chosen before launching the test in order to avoid problems of multiple comparisons. The selection of this parameter is not relevant to the testing of the null hypothesis of independence, but is relevant to geographically identifying clusters. High values of this parameter could identify one cluster formed of several small clusters. Low values allow the identification of more complex forms (e.g.,. a cluster with an 'S' form). The value of 10% is usually selected in the literature.

the alternative hypothesis is that there is a window Z (a set of connected census tracks), so that the probability of finding a CCIs firm is higher inside Z than outside Z.

3.4.1 Technical Details of the Scan-test

In this subsection we briefly present the formal construction of the test. More complete details about the construction of the test can be found in Kulldorff (1997). Let *N* be the total number of firms observed in Barcelona FUA, which we consider divided into discrete areas (census tracks). Let N_i represent the total number of firms in the census track *"i"*. Similarly, *n* and n_i denote the total number of CCIs in the FUA *(n)* and in the census track *'i' (n_i),* respectively. We assume that the number of CCIs in the census track *'i',* namely X_i, follows a binomial $B(n_i,p_i)$ distribution that we can approximate to a Poisson $P(\lambda_i)$ with $\lambda_i=n_ip_i$. Under the null we assume that the distributions in census tracks are independent. Under the alternative hypothesis we assume that there is a set of census tracks, named *Z*, where the probability of finding a CCIs firm is different (higher or lower). Formally, the test is constructed under the hypothesis:

$H_0: \lambda_i = \lambda(\forall i)$ and X_i are iid

$H_A: \exists Z \in \Theta$ where $\lambda_i = \lambda_Z$ if $i \in Z$; $\lambda_i = \lambda_{\bar{Z}}$ $if\ i \in \bar{Z}\ (with\ \lambda_Z \neq \lambda_{\bar{Z}})$

The likelihood function of the spatial process is obtained for the null (L_0) and for the alternative hypothesis ($L_A(Z)$), and the likelihood ratio (named λ_Z) is calculated. After a few calculations, the expression for the likelihood ratio is,

$$\lambda_Z = \frac{L_A(Z)}{L_0} = \left(\frac{N_Z}{E_Z}\right)^{N_Z} \left(\frac{N - N_Z}{N - E_Z}\right)^{N - N_Z}$$

Where N_Z is the total number of firms in the set *Z,* and E_Z is the expected number of CCIs firms under the null. Note that the likelihood ratio depends of the set Z, and, therefore, a ratio must be calculated for each proposed cluster Z. The Scan-test looks for the set *Z*, where the likelihood ratio is maximum. Therefore, the Scan-statistic Λ is defined as,

$$\Lambda = \sup_{Z \epsilon \Theta} \left\{ \lambda_Z \ I(\frac{N_Z}{E_Z} > \frac{N - N_Z}{N - E_Z}) \right\}$$

Where *I(x)* is an indicator function to look for clusters Z, where the number of firms is higher than expected. This indicator function can be changed if the objective is to look for a cluster of under-expected CCIs firms (changing '>' to '<') or it can be deleted if no assumption is considered. *Θ* is the set of all possible connected regions which could be considered in the study area. Typically, this set *Θ* is reduced to only circular and/or elliptic shapes[4], although it is also possible to work with spatial clusters of flexible shapes (**Tango, 2005**). The region *Z*,* where the likelihood ratio reaches the maximum, is named Most Likely Cluster (MLC).

As the theoretical distribution of the Scan-statistic under the null hypothesis is not known, its significance is empirically evaluated by simulating neutral landscapes (obtained by means of a random spatial process) and comparing the empirically computed statistic against the frequency of values obtained from the neutral landscapes. Hence, a *p*-value is obtained through the Monte Carlo hypothesis testing method by comparing the ratings of the maximum likelihood functions of the real dataset with those of the random data sets, with a number *B* of replications. If the MLC Z* is significant, the process is repeated looking for secondary clusters non-overlapping with the MLC. The free software http://satscan.org is available for computing.

3.4.2 Secondary Clusters

If the test rejects the null hypothesis and identifies a significant cluster, a natural question would be to ask if there is another cluster (not overlapping the most likely cluster) whose variance is significantly different from the rest. These clusters are the so-called secondary clusters. Zhang et al. (2010) suggest an iterative method based on eliminating the observations included in the MLC from the sample and

[4] In this study we use elliptic clusters. The relevance of the test using elliptic or circular windows is similar, but selecting elliptic windows allows the test to identify the differential region with more precision than with circular clusters.

re-obtaining the value of the statistic with this subsample, as this procedure is capable of identifying secondary clusters (i.e., the method used in this paper).

4. Results

4.1 Descriptive Statistics

Table 1 shows how the distribution of CCIs firms according to industries for 2009 and 2017 is quite similar. Although the Fashion industry share decreases quite a lot, other industries show an expanding trend (i.e., R+D, Architecture, and Software). The table also shows the distribution of firms in terms of census tracks, with the maximum number of firms in one census track belonging to Fashion firms in 2017 (34), followed by Advertising firms for the same year (30), and then Graphic firms (27).

[Insert Table 1 here]

4.2 Cluster Identification

The analysis is conducted for 2009 (Table 2) and 2017 (Table 3) in order to control for *i)* the temporal continuity of the clusters and *ii)* the potential bias caused by fluctuations in business cycles due to the economic downturn between 2007 and 2014. Concretely, we show data about number, size (the number of firms) and the significance of the clusters (scan statistic), taking into account that only significant clusters (with p-values <0.05) are included. The figures show the graphic location of the clusters.

[Insert Table 2 here]

For 2009 we have identified 2 clusters for total amount of CCIs with, respectively, 248 and 1,345 firms, and 19 clusters at the subsector level that are distributed in the following way: Advertising (2 clusters); Architecture (1); Audio-Visual (2); Fashion (3); Graphic (4); Jewellery (1); Publishing (3); Software (2); and Arts (1).

[Insert Table 3 here]

In 2017 the total number of CCIs (aggregated) clusters remains the same (2 clusters). However, the number of firms in each cluster shows erratic behavior depending on the number of clusters identified. Concretely, considering one cluster from 248 to 1,445 firms, and considering two clusters from 1,345 to 925. As for the number of clusters at the subsector level, it increases and is now distributed as follows: Advertising (3 clusters); Architecture (1); Audio-Visual (1); Fashion (4); Graphic (4); Jewellery (1); Photography (1); Publishing (3); R+D (2); Software (3); and Arts (3).

Apart from the number of clusters, their geographical distribution is important, as firms' preferences in terms of spatial proximity are shaped by the attractiveness of each area and, especially, the potential for agglomeration economies to be generated locally. Figures 2 and 3 show the overall distribution of CCIs clusters, demonstrating the key role played by the city of Barcelona, a result supported by previous analyses (see, for instance, Coll-Martínez et al., 2019 for a specific analysis of this area, but also Boix et al., 2015, for a CCIs cluster analysis throughout Europe) that highlight the urban nature of CCIs clusters (Lazzeretti et al., 2008). This validates the argument presented by Gong and Hassink (2017) on the importance of the quality of place and urban locations in attracting CCIs.

[Insert Figure 2, 3 Here]

Apart from reasonable changes due to firm turnover between 2009 and 2017, Figures 2 and 3 suggest that the benefits of clusters are greater closer to the main agglomerated areas (i.e., in and around Barcelona), as in these places it is easier to maximise interactions. Previous results refer to clusters of CCIs as a whole, but in terms of clusters of specific CCIs, the results are slightly different. These specialized clusters are driven by local sources of competitiveness arising in given industries which reinforce the role played by smaller urban areas.

4.3 Industry-Specific Clusters: Subsectors of CCIs

When referring to the industry-specific cluster results for 2009 (see Figure 4), a clear preference for agglomeration in the core of the metropolitan area has been demonstrated. There is at least one cluster of all the industries in Barcelona city, and the additional ones are in different municipalities of the metropolitan area. This depends on their industry specialization, but they are usually located in cities with a 19th century[5] manufacturing tradition.

In general terms, subsectors linked to the high-tech, cultural, and service-oriented industries tend to cluster in Barcelona, whilst those closely connected with manufacturing activities cluster farther away from the core of the Barcelona FUA. An exception to this close connection to Barcelona city is the Fashion industry cluster, located outside Barcelona city center. However, this CCIs cluster is mainly driven by Fashion firms and not by a wide agglomeration of CCIs firms. Findings on Fashion clusters for the FUA of Barcelona are thus in line with the findings of Polèse et al. (2007) on manufacturing location patterns in Spain. The results show that manufacturing firms follow a constrained decentralized model where they prefer to locate in medium-sized cities close to the major metropolitan areas but not urban centers, and this pattern has been quite stable (between 1991 and 2001). This result is also consistent with the findings by Boix et al. (2015) for European regions, as Fashion firms tend to cluster in the core of the big metropolitan areas of Paris and London but in their peripheries in the case of Barcelona

[Insert Figure 4 Here]

[5] In any case, as shown by Boix et al. (2015) for a European analysis, CCIs clusters differ at the industry level.

Results for 2017 are quite similar to those of 2009, which is reasonable taking into account that cluster formation is a medium to long-term process. Nevertheless, there is one interesting difference that arises when comparing both periods. It seems that clusters located in Barcelona city center have strengthened over this period. This process can be understood in terms of urban resilience during times of economic downturn (Martin and Sunley, 2015) as firms located in dense urban areas are "protected" by a complex network of firm interactions that help them to continue operating in markets, as our results suggest for Barcelona (i.e., a "Barcelona effect"). An additional explanation is provided by the role of public policies supporting cluster formation in areas like the 22@ district in Barcelona (Viladecans-Marsal and Arauzo-Carod, 2012), as high-tech firms in several CCIs have tried to benefit from the advantages existing in these areas. It is also true that competition is tough in these locations, and that increased competition makes survival more difficult, but our results suggest that the net changes are positive. This is in line with the findings by Dyba et al. (2019), who explain that firms in a mature cluster use a greater variety of external knowledge sources and more knowledge-intensive sources than those in growing clusters do. This circumstance may be explained by more homogeneous and well-established knowledge pools in the later stages of a cluster life cycle, and/or by greater competition among firms supplying similar products.

Figure 4 shows clusters at the subsector level. It is worth noting that the number of industries differs across these figures as not all of them have been identified for the 2 years considered. In general terms, we can distinguish clusters between those located in the core of the FUA of Barcelona and those located in its periphery. The core-oriented clusters correspond to industries like Advertising, Audio-Visual, Heritage, Photography, Publishing and Arts; namely, traditional creative industries. This clustering pattern is consistent with findings by Asheim et al. (2017), who emphasized the role of active policy intervention in the media cluster development of Scania (Southern Sweden), a quite similar process to that of the 22@ district in Barcelona, thanks to measures like infrastructure investments, creation of research and innovation centers, location of public universities, etc.

Looking deeper into the previously specified clusters, we have identified several cultural programs and institutions (mainly implemented by the Catalan government using EU Structural Funds and regional funds) that may have favored cluster formation and growth. Firstly, in the core of Barcelona, the clusters of Advertising, Graphic and Audio-Visual firms have strengthened and grown between 2009 and 2017, and two new clusters of Photography and Architecture firms were created in 2017 in an area where they had not been concentrated before. Scanning this geographical area, we find the Disseny Hub Barcelona (established in 2012), a new innovative municipal facility focused on driving the knowledge economy in the design industry. Secondly, at the heart of the new cluster of Photography firms in 2017, we find the Hospital de la Santa Creu i Sant Pau, which is the cultural project that has received the largest amount of funding in absolute terms during the period 2007-2011 in Spain. Thirdly, there are other initiatives inside clustered areas, such as The Barcelona Laboratori, The Creative Research Park, the Institut de Cultura de Barcelona, and the i2cat Foundation. Hence, provided with the detailed geographical level of our findings, specific neighborhoods and districts in the FUA of Barcelona can be found to be indispensable for the support of innovation and creativity in the region. Although we cannot identify the specific nature and direction of the relationship between previous public intervention or funds and the firms inside CCIs clusters, there is empirical evidence suggesting their positive role in the development of creative clusters (Foord, 2008), so it is reasonable to assume that these patterns also apply to the case of Barcelona FUA.

The periphery-oriented clusters correspond mainly to Architecture, Fashion, Graphic, and Jewellery. It seems clear that locational behavior has something to do with the previous economic activities carried out at the local level (i.e., path dependence), factor endowment and the creative "atmosphere" that attracts and retains certain activities. In this regard, our results coincide with those by Kiroff

(2017), as it is reasonable to assume that architecture firms are attracted to the heritage buildings of an area, its unique imagery, and the local brand of locations other than the urban core of the city, suggesting that other location factors could be creative industry sector dependent. Thus, the characteristics of a place play an important role.

There is also evidence of industries that seem to follow both strategies (i.e., core and periphery), such as Software, which is distributed in several clusters in Sant Cugat del Vallès, in the 22@ district, and the Diagonal avenue in Barcelona. Nevertheless, we guess that this result is partially biased by the industry aggregation level used in this paper (i.e., software and video-game firms are grouped together), as there is clear empirical evidence showing the existence of a concentration of video-game firms in 22@ (Méndez-Ortega and Arauzo-Carod, 2019), where they benefit from the large knowledge spillovers arising from a concentration of similar firms and the existence of several training institutions and specialized suppliers.

It is also interesting to notice that high-tech industries like R+D and Software show some sort of suburbanization in Vallès Occidental county. Several high-tech firms have located in that area in recent years (especially in and around Sant Cugat del Vallès and the Autonomous University of Barcelona), helping to upgrade the traditional manufacturing base existent before in a process similar to that described by Asheim et al. (2017). The interactions among several cluster actors (e.g., public and research institutions) is an important factor in the attraction of high-tech firms and the development of spin-off dynamics from big firms.

A general approach to previous results indicates that, due to asymmetries, space matters and firms look for these asymmetries when deciding on the location of their venues. That is why several specialized clusters emerge and survive throughout time, attempting to take advantage of existing business and social ties in different locations as well as the availability of specialized labor and infrastructures, public resources, and intermediate and final markets.

5. Conclusions

This paper has shed some light on CCIs clustering, focusing on the specific case of Barcelona FUA. Although clustering patterns have been extensively analyzed for economic activity as a whole and for some manufacturing industries, empirical evidence regarding CCIs is still scarce. There are several analyses of clustering patterns in these industries, however, these are made mainly from a qualitative perspective, without providing strong empirical evidence supporting clustering behavior.

This paper contributes to the empirical literature of CCIs spatial patterns with the following findings: *i)* CCIs firms tend to cluster, especially in core or urban areas (e.g., in and around Barcelona), *ii)* there are structural differences at the industry level in terms of clustering, *iii)* clustering patterns are quite stable in the short and medium term, and *iv)* there is urban resilience (i.e., a “Barcelona effect”) benefiting CCIs clusters.

There are several policy implications arising from this paper. The first one refers to the natural tendency of firms to cluster, which is also true for CCIs. This fact suggests the advantages of providing location conditions to facilitate similar industry cluster formation, assuming that if firms look for neighbors similar to themselves, it is because they benefit from this geographic proximity. The second one refers to the urban resilience identified when comparing the cluster maps for 2009 and 2017. In this sense, if dense urban areas (e.g., Barcelona) provide additional resilience, then public administrations should take this urban effect into account when designing land planning for specific economic activities. Finally, the third one suggests that, although there is a clear tendency to cluster inside big urban areas, there is still room for smaller cities to house specialized CCIs clusters.

The main limitation of this paper refers to the dataset. This paper relies on Mercantile Register data (i.e., SABI), which is the most common source of information for studies based on the location of economic activity in Spain. Although this dataset provides a clear picture of the overall distribution of economic activity, it is about firms, not about establishments. This issue could be a problem in the case of multi-plant firms, but these are unusual in CCIs.

As for future extensions of this research, it is clear that after identifying where and when CCIs cluster, it is necessary to analyze whether that pattern has any effect in terms of firm efficiency and/or turnover (i.e., entry and exit). Therefore, a future extension of this paper will concentrate on the effects of clusters in terms of the locational determinants of firms belonging to the same CCIs in order to check whether the benefits of clusters are perceived as strong locational determinants by entering firms. Additionally, departing from our results, there is room for additional research that attempts to evaluate the impact of local, regional, and EU funds used to promote CCIs in order to quantify their (positive) effect for some clusters.

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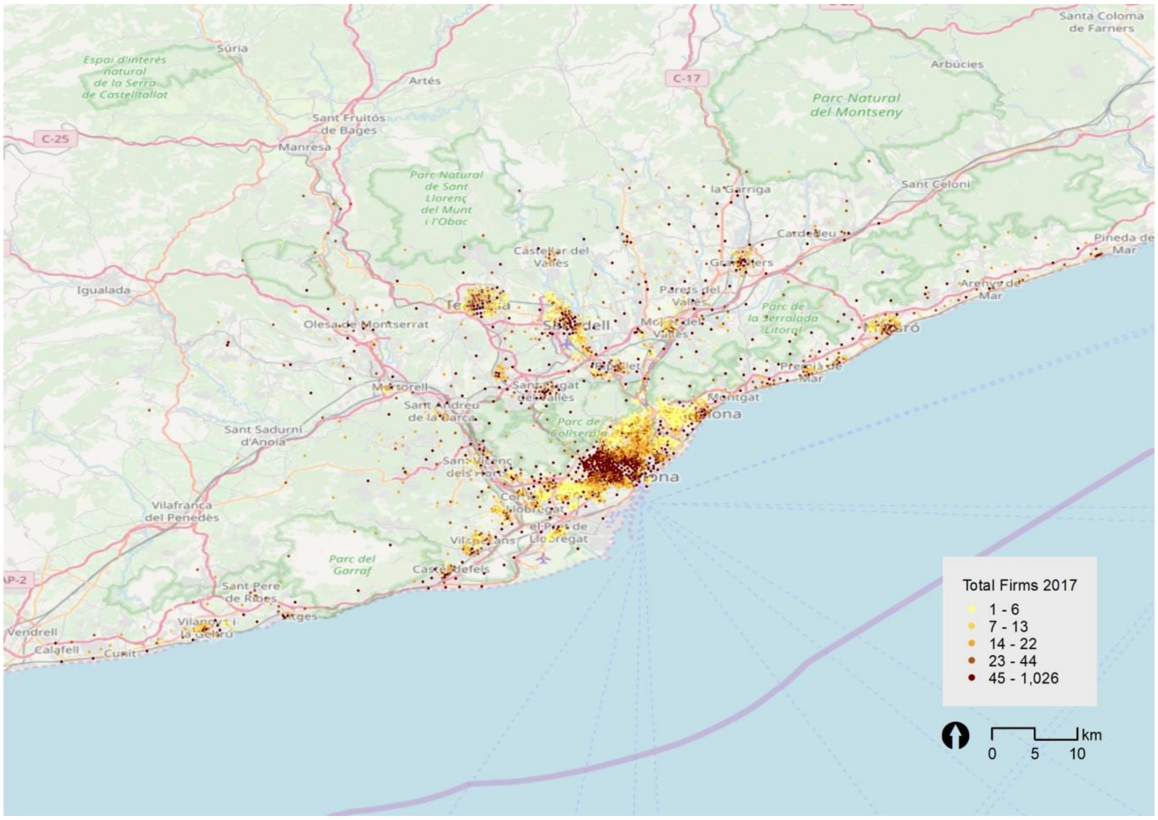
Figures

Figure 1 Spatial Distribution of Firms in the Functional Urban Area of Barcelona



Source: own elaboration.

Figure 2 Cultural & Creative Industries (All Inclusive) (Elliptic Clusters, 2009)

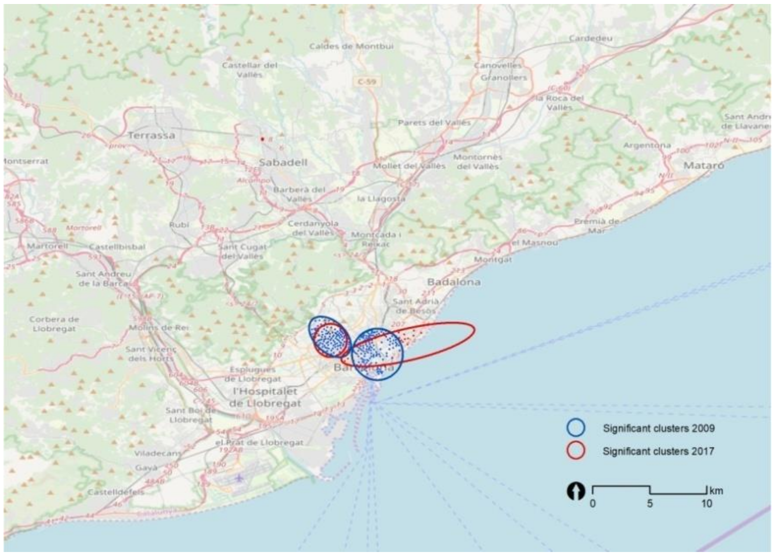
Source: own elaboration.

Figure 3 Cultural & Creative Industries (All Inclusive) (Elliptic Clusters, 2017)

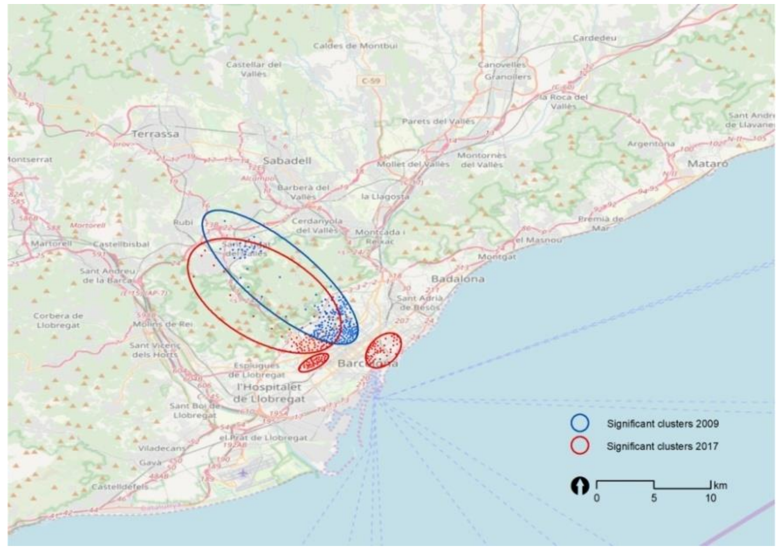
Source: own elaboration.

Figure 4 Subsectors in Cultural & Creative Industries (Elliptic Clusters, 2009-2017)[6]

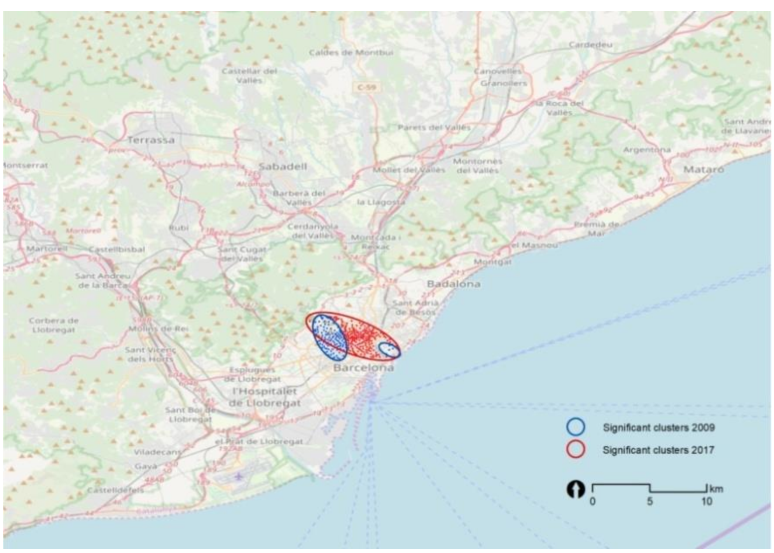
Advertising



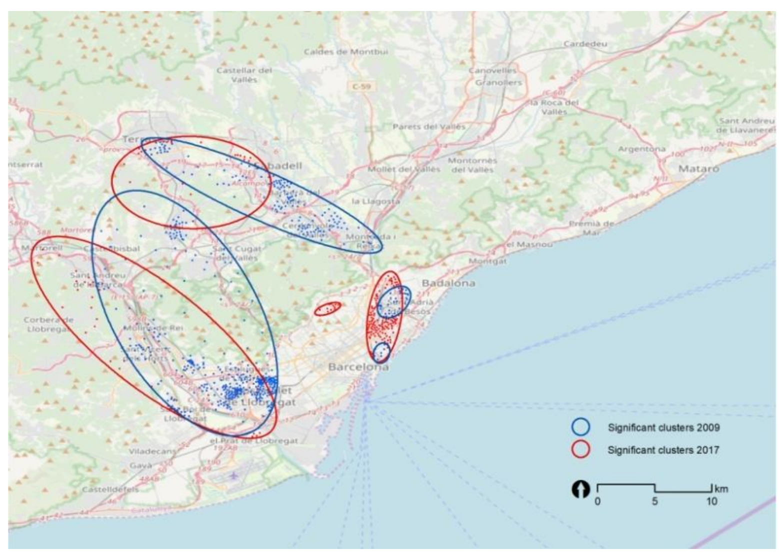
Architecture and Engineering



Cinema



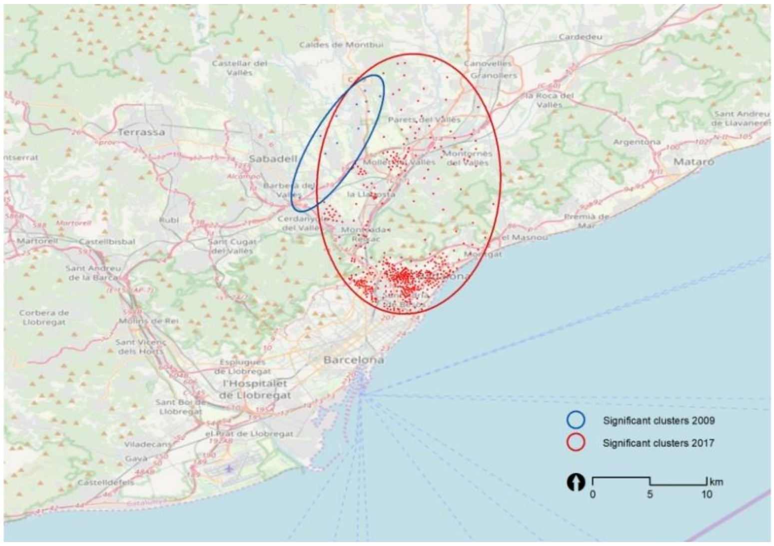
Graphic Arts and Printing



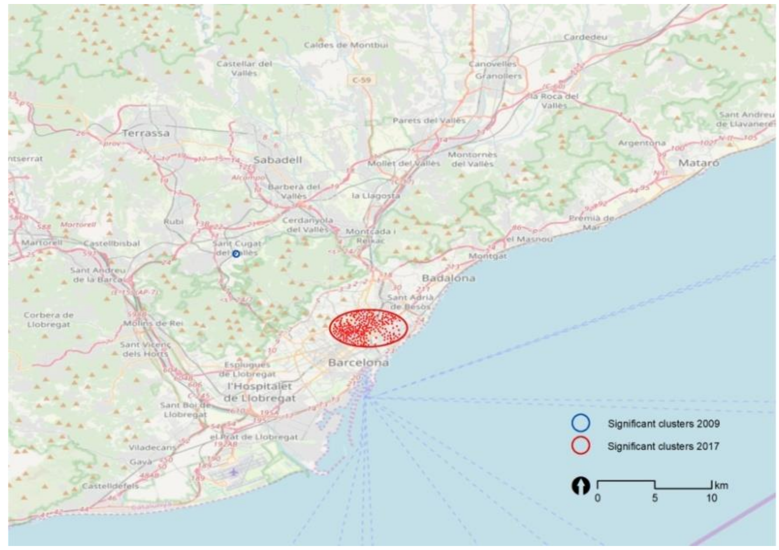
[6]As we do not detect any significant clusters for "Activities related to Heritage", we only provide maps for 11 subsectors rather than 12.

(cont.)

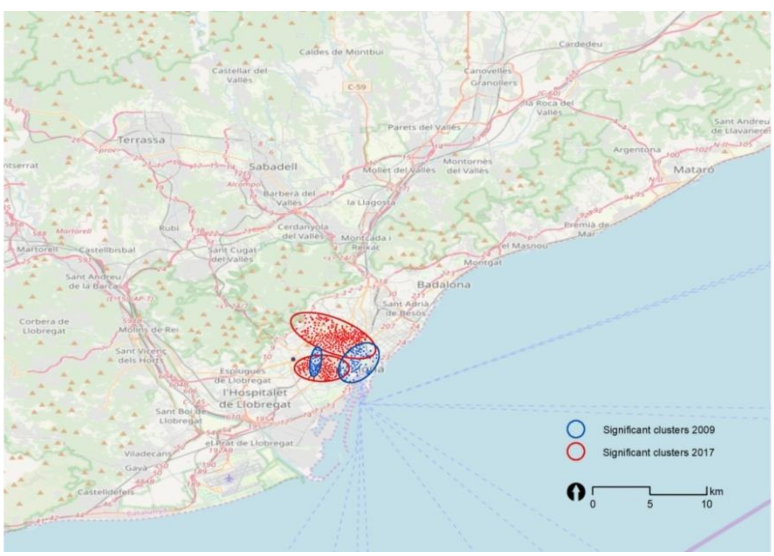
Jewellery, Music Instruments and Toys



Photography



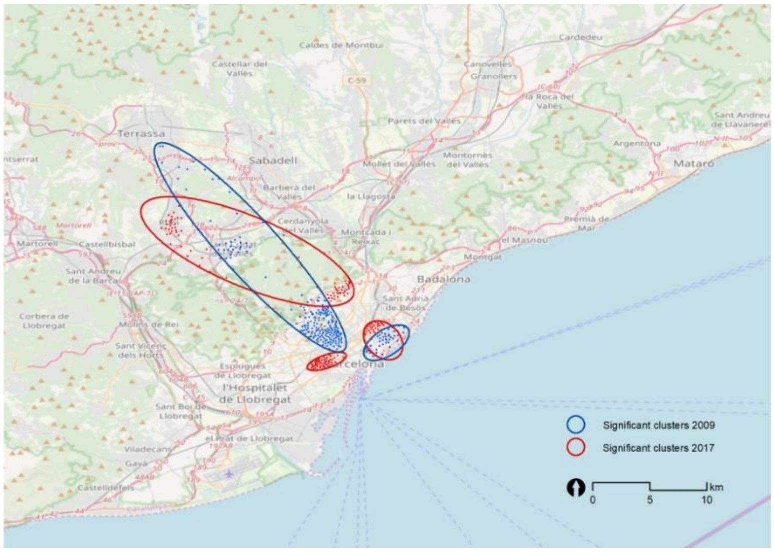
Publishing



Research and Development

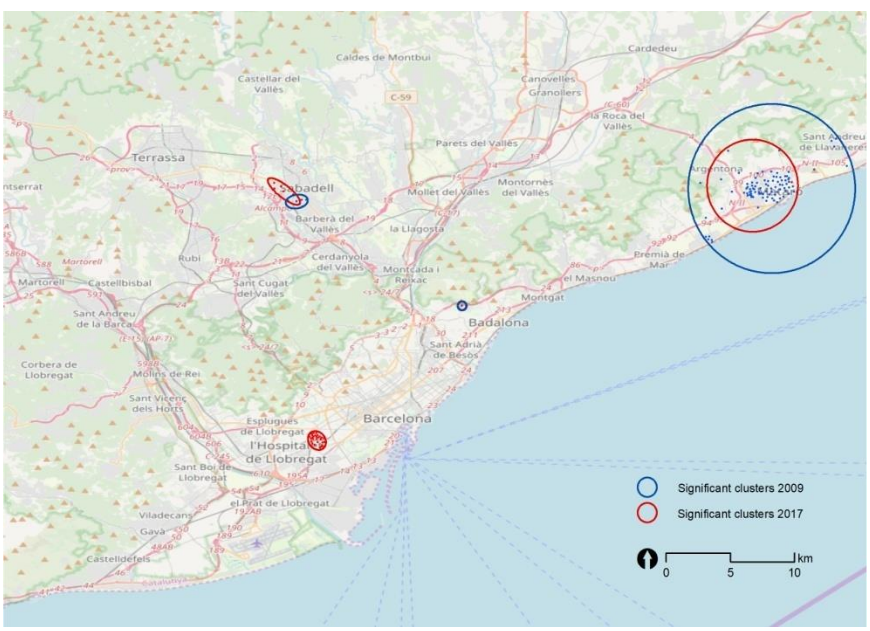
(cont.)

Software and Videogames



Writing, Performing Arts, Visual Arts and Crafts

Fashion



Source: Own elaboration

Tables

Table 1: Descriptive Statistics: Number of firms in the Functional Urban Area of Barcelona (2009 and 2017)/Distribution by census track

		Number of Firms	% of CCIs	Mean	Min	Max	SD
Advertising	2009	1769	16.6	0.57	0	31	1.56
	2017	1412	16.1	0.46	0	30	1.55
Architecture and Engineering	2009	2239	21.1	0.73	0	23	1.61
	2017	2215	25.2	0.73	0	19	1.63
Cinema, Music, TV and Radio	2009	865	8.1	0.28	0	23	0.98
	2017	693	8.0	0.23	0	18	0.82
Fashion	2009	1068	10.0	0.35	0	31	1.12
	2017	526	6.0	0.17	0	34	1.06
Graphic Arts and Printing	2009	1565	14.7	0.51	0	32	1.01
	2017	1106	12.6	0.36	0	27	0.02
Jewellery, Music Instruments and Toys	2009	377	3.5	0.12	0	8	0.42
	2017	279	3.2	0.09	0	6	0.37
Photography	2009	271	2.5	0.09	0	5	0.34
	2017	181	2.1	0.06	0	7	0.29
Publishing	2009	854	8.0	0.28	0	14	0.85
	2017	588	6.7	0.19	0	14	0.58
Research and Development	2009	147	1.4	0.05	0	5	0.25
	2017	223	2.5	0.07	0	17	0.82
Software and Video-games	2009	976	9.2	0.32	0	13	0.93
	2017	1123	12.7	0.37	0	23	1.23
Writing, Performance Arts, Visual Arts and Craft	2009	461	4.3	0.15	0	9	0.52
	2017	396	4.5	0.13	0	6	0.45
Activities Related to Heritage	2009	44	0.4	0.01	0	3	0.13
	2017	33	0.4	0.01	0	2	0.11
Total CCIs	2009	10635	100	3.5	0	111	7.21
	2017	8775	100	2.88	0	110	6.39
Total Firms	2009	130313		42.25	1	106	75.5
	2017	98422		32.28	1	1026	60.48
%CCIs from Total Firms	2009	8.16					
	2017	8.94					

Source: own elaboration

Table 2: Cultural & Creative Industries (Clusters-Elliptic at 10%). Year 2009

Industry	Nb	Size	Nz	Nf	ENf	Nf/ENf	Λ	p-value
Total Cultural & Creative Industries	1	8	1,229	248	101.8	2.4	75.7	<0.001
	2	124	12,944	1,345	1072.0	1.3	34.0	<0.001
Advertising	1	131	12,971	297	176.1	1.7	38.3	<0.001
	2	156	10,818	216	146.9	1.5	15.7	<0.001
Architecture & Engineering	1	237	11,584	288	199.0	1.4	16.8	<0.001
Cinema, Music and TV	1	118	13,004	173	86.3	2.0	36.4	<0.001
	2	6	1,386	45	9.2	4.9	34.3	<0.001
Fashion	1	94	3,920	130	32.1	4.0	88.6	<0.001
	2	1	168	28	1.4	20.3	58.1	<0.001
	3	5	568	20	4.7	4.3	13.6	0.005
Graphic Arts & Printing	1	32	1,168	51	14.0	3.6	28.7	<0.001
	2	388	12,378	239	148.7	1.6	24.6	<0.001
	3	6	1,124	40	13.5	3.0	16.8	<0.001
	4	147	6,349	127	76.2	1.7	11.1	0.045
Jewellery, Music Instruments & Toys	1	16	1,543	20	4.5	4.5	12.8	0.011
Publishing	1	1	153	14	1.0	14.0	24.0	<0.001
	2	86	7,746	103	50.8	2.0	21.9	<0.001
	3	37	4,151	68	27.2	2.5	19.5	<0.001
Software and Video-games	1	43	3,012	57	22.6	2.5	17.9	<0.001
	2	215	12,799	162	95.9	1.7	16.0	<0.001
Writing, Performing Arts, Visual Arts and Crafts	1	175	10,546	94	37.3	2.5	29.6	<0.001

Nb = number of significant clusters; Size = number of locations that form the cluster; Nz = number of firms in the cluster; Nf = number of firms in the specified sector (cultural and creative industries); ENf = Expected number of firms in the specified sector (cultural and creative industries); T-stat = statistic value; P-value = p-value indicates significant level

Source: own elaboration.

Table 3: Cultural & Creative Industries (Clusters-Elliptic at 10%). Year 2017

Industry	Nb	Size	Nz	Nf	ENf	Nf/ENf	Λ	p-value
Total Cultural & Creative Industries	1	302	9,824	1,445	875.9	1.6	140.3	<0.001
	2	154	8,318	925	741.6	1.2	21.8	<0.001
Advertising	1	105	9,833	314	141.4	2.2	90.7	<0.001
	2	99	9,778	255	140.3	1.8	32.1	<0.001
	3	1	35	9	0.5	18.0	17.5	0.00
Architecture & Engineering	1	165	9,589	373	215.8	1.7	50.2	<0.001
Cinema, Music and TV and radio	1	278	9,787	191	68.9	2.8	74.0	<0.001
Fashion	1	80	2,235	108	12.0	9.0	151.3	<0.001
	2	1	104	34	0.6	61.2	107.5	<0.001
	3	7	541	20	2.9	7.0	18.9	<0.001
	4	33	236	10	1.3	8.0	11.8	0.02
Graphic Arts & Printing	1	267	6,998	173	78.6	2.2	40.3	<0.001
	2	158	3,899	117	43.8	2.7	38.4	<0.001
	3	74	2,744	73	30.8	2.4	20.4	<0.001
	4	11	123	11	1.4	7.9	11.5	0.03
Jewelry, Music Instruments & Toys	1	484	9,653	57	27.4	2.1	13.7	0.005
Photography	1	260	6,954	37	12.8	2.9	16.0	0.00
Publishing	1	260	9,642	144	57.6	2.5	45.9	<0.001
	2	1	179	14	1.0	13.1	23.2	<0.001
	3	139	9,148	102	54.7	1.9	17.4	0.00
Research & Development	1	1	207	17	0.5	36.2	45.1	<0.001
Software and Video-games	1	57	2,448	83	27.9	3.0	36.0	<0.001
	2	108	3,916	96	44.7	2.1	20.2	<0.001
	3	52	4,241	95	48.4	2.0	16.0	0.00
Writing, Performing Arts, Visual Arts and Crafts	1	115	5,797	73	23.3	3.1	36.3	<0.001
	2	25	2,379	31	9.6	3.2	15.3	0.00
	3	102	3,734	38	15.0	2.5	12.7	0.01

**Activities related to Heritage have no significant clusters in both years 2009 and 2017

** Photography and Research and Development have significant clusters in 2017 but NOT in 2009

***Firms related to the "Design" have no data in the SABI, i.e. we did not find firms registered under this category

Nb = number of significant clusters; Size = number of locations that form the cluster; Nz = number of firms in the cluster; Nf = number of firms in the specified sector (cultural and creative industries); ENf = Expected number of firms in the specified sector (cultural and creative industries); T-stat = statistic value; P-value = p-value indicates significant level

Source: own elaboration.

Appendix 1

This appendix shows the CCIs definition for this study along with their 4 and 5-digits NACE Rev. 2. For 2009 and equivalence for NACE 93 Rev. 1

	NACE 2009	Equivalence NACE 93 Rev. 1
Fashion		
Manufacture of leather garments	1411	18100
Preparation of work clothes.	1412	18210/25241
Preparation of other outer garments.	1413	18221/18222/25241
Making of underwear.	1414	18231/18232
Manufacture of other garments and accessories.	1419	17710/18241/18242/18243
Hosiery manufacturing	1431	17710
Manufacture of other knitwear.	1439	17720
Dressing, tanning and finishing of leather; Preparation and dyeing of skins.	1511	18301/19100
Footwear manufacturing	1520	19300
Graphic Arts and Printing		
Graphic arts and related services.	1811	22210
Other printing and graphic arts activities.	1812	22220
Prepress and media preparation services.	1813	22240/22250
Binding and related services.	1814	22230
Specialized design activities.	7410	74841
Jewellery, Music Instruments and Toys		
Manufacture of jewellery and similar items.	3212	33500/36221/36222
Manufacture of jewellery and similar items.	3213	33500/36610
Manufacture of musical instruments.	3220	36300
Manufacture of games and toys.	3240	36500
Other manufacturing industries n.c.o.p.	3299	18243/19202/20510/20521/22110/25130/25241/26820/28753/33100/36630
Publishing		
Book edition	5811	22110
Editing directories and postal address guides.	5812	22110/72400
Newspaper edition	5813	22120
Editorial of magazines	5814	22130/72400
Other editorial activities	5819	22150/22220/72400
Software and Videogames		
Videogame edition	5821	72210/72400
Editing other computer programs	5829	72210/72400
Computer programming activities	6201	72220/72400
Computer consulting activities	6202	72100/72220
Cinema, Music, TV and Radio		
Postproduction activities of film, video and television programs.	5912	92112
Film exhibition activities.	5914	92130
Film and video production activities.	5915	92111

Activities of television program productions.	5916	92202
Activities of distribution of films and videos.	5917	92121/92122
Distribution activities of television programs.	5918	92202
Activities of sound recording and music editing.	5920	22140/72400/74843/92112/92201
Broadcasting activities	6010	64200/72400/92201
Programming activities and television broadcasting.	6020	64200/72400/92203
Reproduction of recorded media.	1820	22310/22320/22330
Architecture and Engineering		
Architectural technical services	7111	74201
Technical engineering services and other activities related to technical advice.	7112	74202/74203/74204
Research and Development		
Research and experimental development in biotechnology.	7211	73100
Other research and experimental development in natural sciences and techniques.	7219	73100
Research and experimental development in social sciences and humanities.	7220	73100/73200
Advertising		
Advertising agencies	7311	74401/74402
Photography		
Photography activities	7420	74811/74812/92400
Writers, Performing Arts, Visual Arts and Crafts		
Performing Arts	9001	92311/92312/92343
Auxiliary activities to the performing arts.	9002	92313/92342/92343
Artistic and literary creation.	9003	92311/92400
Management of exhibition rooms.	9004	92320
Heritage Activities		
Activities of the museums	9102	92521
Management of historical places and buildings.	9103	92522
Activities of botanical gardens, zoos and nature reserves.	9104	92530
Activities of the library	9105	92510
File activities.	9106	75140/92510

Source: Developed by the authors; CCIs selection adapted from the literature, and codes equivalence adapted from INE (National Statistics Institute, 2010) and based on authors' own judgment.