UNIVERSITAT ROVIRA I VIRGILI
DEPARTAMENT D'ECONOMIA

CREIP
CENTRE DE RECERCA EN ECONOMIA INDUSTRIAL I ECONOMIA PÚBLICA

WORKING PAPERS

Col·lecció "DOCUMENTS DE TREBALL DEL DEPARTAMENT D'ECONOMIA - CREIP"

Do Software and Videogames firms share location patterns across cities? Evidence from Barcelona, Lyon and Hamburg

Carles Méndez-Ortega
Josep Maria Arauzo-Carod

Document de treball n.9 - 2018

DEPARTAMENT D'ECONOMIA – CREIP
Facultat d'Economia i Empresa

UNIVERSITAT ROVIRA I VIRGILI

DEPARTAMENT D'ECONOMIA

Edita:

Departament d'Economia
www.fcee.urv.es/departaments/economia/public_html/index.html
Universitat Rovira i Virgili
Facultat d'Economia i Empresa
Av. de la Universitat, 1
43204 Reus
Tel.: +34 977 759 811
Fax: +34 977 758 907
Email: sde@urv.cat

CREIP
www.urv.cat/creip
Universitat Rovira i Virgili
Departament d'Economia
Av. de la Universitat, 1
43204 Reus
Tel.: +34 977 758 936
Email: creip@urv.cat

Adreçar comentaris al Departament d'Economia / CREIP

ISSN edició en paper: 1576 - 3382
ISSN edició electrònica: 1988 - 0820

DEPARTAMENT D'ECONOMIA – CREIP
Facultat d'Economia i Empresa

Do Software and Videogames firms share location patterns across cities? Evidence from Barcelona, Lyon and Hamburg

Carles Méndez-Ortega (♣): carles.mendez@urv.cat

Josep-Maria Arauzo-Carod (♣): josepmaria.arauzo@urv.cat

Abstract:

The aim of this paper is to analyse common location patterns of Software and Videogames (SVE) industry in Barcelona, Lyon and Hamburg. This is a key industry in developed countries that mainly located at core of bigger metropolitan areas, looking for agglomeration economies, skilled labour and a wide range of spillover effects existent there. Cities used in our empirical application share some common features in terms of size, manufacturing tradition and, specially, economic strategies, as they have managed to promote high-tech neighbourhoods through ambitious urban renewal policies. When analysing location patterns of firms from these industries, although our results highlight predominant role of urban cores of three cities, also indicate important specificities in terms of core-periphery distribution of SVE's firms.

JEL Codes: R12, C60, L86, N90

Keywords: Software Industry, microgeographic analysis, spatial location patterns, Barcelona, Hamburg, Lyon

(♣) QURE & CREIP, Department of Economics (Universitat Rovira i Virgili); Av. Universitat, 1; 43204 – Reus

1. Introduction

Nowadays, location patterns of firms belonging to high-tech industries are receiving an increasing attention by both academics and policy makers. This attractiveness can be easily explained because in developed and emerging countries these activities are growing over national average and, consequently, new firms and jobs are being created. Nevertheless, these industries do not represent only an important source of economic growth through firms and jobs, but also a key challenge for the competitiveness of the areas generating and attracting high-tech firms. In this sense, high-tech industries contribute in a stronger way to growth (i.e., broadly speaking, markets tend to expand), demand skilled labour, do not imply intensive consumption of land, and do not generate negative environmental effects. To sum up, stronger specialisation in these industries is a desirable outcome for most of economies that can satisfy locational requirements of these firms, which is the point that this paper wants to contribute to, as not all potential sites may be appropriate venues for a high-tech firm. In this regard, worldwide empirical evidence shows that these firms prefer dense urban environments and, more specifically, cores of big metropolitan areas, although that there are some noticeable specificities according to each subsector. This location behaviour does not respond only to some kind of path dependence in view that, traditionally, high-tech firms have located in urban cores, but to the necessity to benefit from knowledge spillovers (a key input for these firms) that tend to cluster at urban cores.

Despite of the relevance of high-tech industries as a whole, this paper aims to focus on a specific group of these industries that have experienced a very dynamic trend in recent years and that are hypothesized to continue in a similar way in next years. We refer to Software and Videogames (hereafter SVE) industries, which currently benefit for massive growth rates, contribute to myriads of new firms, and hire huge number of skilled engineers. Location patterns of these industries respond exactly to aforementioned urban core profile, even if at city level there are specificities to be taken into account. In addition to their high-tech profile, SVE's are considered as part of Creative Industries, which are defined as those economic activities that use creativity as one of the main inputs and that provide tangible (or intangible) goods or services that may generate revenues from trade and/or intellectual property (UNCTAD, 2010). In terms of location patterns of Creative Industries, there is

plenty of empirical evidence highlighting their strong preference for core areas of bigger cities (Coll-Martínez et al., 2017), a centralisation pattern even stronger than for high-tech industries.

In this paper we have selected three European capitals and their metropolitan areas as case study (Barcelona, Lyon and Hamburg). These cities are of a similar size, share a common manufacturing heritage, are not country capitals and have settled down relevant city strategies trying to orientate economic activities around technology, concretely through ambitious urban renewal policies that have transformed previously peripheral low-income neighbourhoods into magnets of knowledge and economic activity generation, based on new technologies. As a consequence, SVE's firms have clustered in and around urban cores of these cities, in a process that has pulled many other related activities, as some technical events (e.g., professional exhibitions, gaming conventions) and education programs (both at undergraduate and graduate level) at local universities. Interestingly, in spite of these similarities, these cities have some differences in terms of location patterns of SVE's firms. In this sense, although in three cities SVE's firms locate at core areas, the intensity of centralization varies across them, as firms in Hamburg are strongly agglomerated at central areas, a phenomenon which is weaker for Barcelona and, specially, for Lyon. Nevertheless, there is a common pattern for all three areas, as SVE's firms co-locate close to firms belonging to other creative industries as Radio and TV, Advertising and Video and film industries. Although reasons behind that co-location are out of the scope of this paper and are left for future research, it is reasonable to assume that there are not only shared location patterns among SVE's firms and firms from these industries, but also some inter-industry linkages that favour spatial proximity.

Main aim of this paper is to explain how video games and software firms locate in urban areas focusing on *i)* their materialised preferences in terms of central vs. peripheral locations, and *ii)* the agglomeration strategies of these firms (i.e., whether SVE's firms tend to be located close to firms of the same industry or to other Creative Industries). Our assumption is that in addition to industry-specific characteristics that determine some external requirements by these firms (*e.g.*, accessibility to skilled labour or specialised IT

suppliers), there are some city-specific characteristics (e.g., urban policies, spatial distribution of economic activity, neighbourhood specialisation) that also matter and shape location decisions taken by these firms, although their analysis is out of the scope of this paper.

In this paper we are interested in both software and videogames firms, but as videogames industry is quite recent (i.e., first firms were created during the 1970s), the availability of empirical evidence is, unfortunately, still scarce. That's why for some analyses we will consider both industries together, even if they locational patterns are not strictly the same. Then, considering SVE's as a whole, it is a leading and influential industry that has important annual growth rates. Concretely, in 2010 SVE's contributed with 5.4% to world GDP (Dutta and Mia, 2010). Firms from SVE's industries tend to locate at urban cores, as in these areas it is easier to obtain the skilled workforce employed at SVE's firms and the creative environment in which knowledge flows are stronger. In this sense, there is wide evidence about the importance of these skilled young professionals (i.e., computer programmers or software engineers) for SVE's firms (Autor et al., 2003). This workforce is a basic input for SVE's firms and for all urban economic growth (Berger and Frey, 2015).

The rest of the paper is organised as follows. Section 2 reviews *i)* the theoretical and empirical literature about firms' location determinants focusing on the importance of this industry for this cities, and *ii)* the case of Barcelona, Lyon and Hamburg from an historical and urban renewal strategic point of view. Section 3 describes data and methodology. Section 4 introduces some descriptive statistics and discusses results and, finally, section 5 presents main conclusions.

2. Location patterns of the software industry and common trends of Barcelona, Lyon and Hamburg

As stated before, the aim of this paper is to compare location processes of videogames and software firms located in Barcelona, Lyon and Hamburg and in their metropolitan areas. These cities have been selected according to *i)* their importance in terms of attractiveness of

firms from these industries, *ii)* their similar size, which makes them easily comparable, and *iii)* they shared institutional characteristics. Concretely, *i)* these cities have attracted a large number of video games and software firms at the same time that local endogenous firms have emerged; *ii)* according to recent data Hamburg is the biggest one with 1.7 million inhabitants (2015), followed closely by Barcelona with 1.6 million (2016) and, at a greater distance, by Lyon with 0.5 million (2014); *iii)* these cities play an important institutional role in their respective countries[1] but they are not country capitals, which implies that although they benefit from some administrative roles (i.e., regional capitals) but without supporting the advantages and disadvantages associated to country capitals.

Industry-specific characteristics that influence location decisions have been analysed in some previous papers, both from a spatial approach, as those of Méndez-Ortega and Arauzo-Carod (2017) and Coll-Martínez *et al.* (2017) for Barcelona and Murphy *et al.* (2015) for Dublin, and from a firm-approach, as those of Berger and Frey (2015) and Autor *et al*. (2003). Scarcity of empirical contributions is easily explained as video games and software are young industries that have only exploded in terms of number of firms and employees in recent years. Nevertheless, as these are fast-growing industries and their economic impact is boosting, it is reasonable to expect a large flow of academic contributions in upcoming years as this industry keep growing.

When discussing city-specific characteristics that may influence location decisions, numerous papers analyse that there is a potential growth in the number of high tech firms located in central areas of big cities, a phenomenon that occurs mainly in western cities fuelled by agglomeration economies, social relations, high skill workers, institutions, talent and human synergies (Florida and Mellander, 2016; Indegaard, 2013, 2009 and Hutton, 2009, 2006, 2004). Concretely, these central areas act as "territorial innovation systems" (Morgan, 2004) that favour innovation activities carried out by firms.

There are also several papers that analyse the positive effect of "techno neighbourhoods"

[1] Barcelona is the second largest city in Spain and the capital of the region of Catalonia, Lyon is the third largest city in France and the capital of the region of Auvergne-Rhône-Alps, and Hamburg is the second largest city in Germany and one of the 16 German states.

(Duvivier and Polèse, 2017) in terms of attraction of economic activity, economic growth and employment generation (Foord, 2013; Viladecans-Marsal and Arauzo-Carod, 2012; Rantisi and Leslei, 2010; Pratt, 2009; and Bagwel, 2008). Some of these cases are related to urban policies aiming to generate clusters of these type of firms (*i.e.*, top-down strategies) and also those coming from local clusters being generated by firms' decisions (*i.e.*, bottom-up strategies) (Fromhold-Eisebith and Eisebith, 2005), taking into account that all policies must be adapted to local economic and social conditions (Boekholt and Thuriaux, 1999), specially in terms of entrepreneurial stock of firms[2]. Obviously, both processes are interrelated and causality may act in both directions, as some urban policies are driven by ex-ante decisions taken by firms and some firms' strategies are triggered by urban policies favouring creation of video games and software firms' clusters. Aforementioned urban policies should depart from existing advantages of urban areas that, potentially, may take them to cluster formation, although uncertainty remains important and there is plentiful evidence of unsuccessful experiences (Braunerhjelm and Feldman, 2006) that may be explained in terms of lack of connection of public projects with existent economic activity (Globerman *et al*., 2005). This point is extremely important for these industries in which turnover rates are quite high, in view of *i)* markets' dynamism and *ii)* low entry barriers (*i.e.*, amount of capital needed to start a new firm is very low). Accordingly, flows of entering and exiting firms are very important and larger than for most of industries and spatial distribution of these firms changes constantly although some key patterns persist.

Given previous considerations, the experiences of Barcelona, Lyon and Hamburg are of clear interest, specially because their urban models differ in terms of core-periphery patterns and previous growth trends but, at the same time, they share some important urban renewal policies carried out in recent years. In general terms, experiences of these cities depart from ambitious urban transformation projects (22@ in Barcelona, *Confluence* in Lyon and *HafenCity* in Hamburg) that aim to renew lagged areas into hubs of high-tech activities, knowledge generation and economic transformation. Nevertheless, it is important to notice that in spite of their similarities, extend, budget and success of these urban renewal plans differ considerably.

[2] See Feldman *et al*. (2005) for a theoretical approach.

Barcelona has been affected by important economic structural changes in recent years, especially after the Olympic Games of 1992 that collaborated to generate an inflexion point in terms of internationalisation and economic transformation of the city. In this sense, the Poblenou district, that traditionally hosted mature manufacture activities, started a huge shift aiming to move from a XIXth century manufacturing activities to a XXIth century service activities. This strategy driven by local city council was called 22@[3] and helped to radically transform a huge area of the city quite close to urban core (Poblenou district). This has been a very successful policy that "managed to attract new firms from knowledge economy and transform an industrial structure based on mature manufacturing activities to one based on high-tech services provided by both private and public institutions" (Viladecans-Marsal and Arauzo-Carod, 2012, p. 398). Nonetheless the urban renewal process, whose success is undeniable, there are some doubts about whether 22@ project has given absolute priority to economic transformation from mature to high-tech industries, as considerable public efforts have also been putted into supply and improvement of high-quality housing in that area.

Lyon shows some similarities with Barcelona as this city has an important manufacturing tradition coming from previous centuries[4], and has also some dissimilarities, as there are a couple of high-tech industries in which Lyon has an international reputation (pharmaceutical and bio-engineering). Although Lyon was not specialised in computer-related activities, this industry was boosted by the creation and location of worldwide leader firms in computer games (*Infogrames* and *Electronic Arts*, respectively) and *Confluence* quartier urban project, which is pretty similar to 22@ in Barcelona, but with additional emphasis into urban renewal designed to improve quality of life and, specially, to implement urban sustainable criteria.

Finally, Hamburg plays also a key role in this industry, as it is the most important German city for software and videogames firms. *HafenCity* project started in 2001 and has transformed a large part of the city (around 157 ha).[5] Concretely, this project is about urban

[3] See Oliva (2004) for a detailed analysis of 22@ project.
[4] Though some of most important firms had moved their headquarters to Paris (Moriset, 2003).
[5] *HafenCity* project is co-financed by private (€8.5 billion) and public investment (€2.4 billion).

renewal of the former Hamburg port, on the Elbe river. It is important to stress that *HafenCity* does not focus only on software and video games industries, but also on retail firms, restaurants, residential buildings, hotels, entertainment activities, offices and a cruise ship terminal. Although expectations are to receive important positive effects over these activities, it is also true that some period is needed in order to fully develop *HafenCity* projects and check their success.

[INSERT FIGURE 1]

Figure 1 shows SVE's yearly entries for each metropolitan area and the announcement data for each urban renewal project (i.e., 2000 for Barcelona, 1999 for Lyon and 1997 for Hamburg). A closer look to this figure shows how announcements foster entries in Lyon and Hamburg in following years, whilst for the case of Barcelona peak of entries were the year that the project was announced.[6]

Apart from previous specificities, all three cities share basic locational requirements from high-tech firms as accessibility (high-speed trains, airports and highways), availability of skilled labour (existence of reputed universities and post-graduated programs), high standards of quality of life (high-quality housing, cultural and recreational amenities), integration in a large and diversified market (European Union), and a previous network of firms of the same industry. These industry-specific assets increased attractiveness of these locations as they lower operational costs (Malmberg and Maskell, 2002) and stir up clusters' viability (Malmberg and Maskell, 2006).

3. Data and Methodology

3.1. Data

Data used in this paper comes from different sources. About firms from Barcelona metropolitan area, data comes from the *Àrea de Cultura Digital* (*Institut Català de les*

[6] We hypothesise that as 22@ Project in Barcelona took a lot of years until it was formally launched potential investors may have had most of relevant information of this Project in advance and, therefore, had anticipated their entry decisions some years before official announcement.

Empreses Culturals) and SABI (*Sistema de Análisis de Balances Ibéricos,* INFORMA). The former one is a department of Government of Catalonia that is responsible for digital media activities including Videogames, books and music, and the latter compiles data on firms using the Register of Companies. The data at firm level for SVE's firms and the rest of creative firms are from the SABI Database, while the data from the metropolitan areas of Lyon and Hamburg comes from Orbis Database, a worldwide database that contains detailed data of more than 200 million firms around the world[7]. From these datasets we obtain the constitution year, the address and the activity code of each firm in the interest to identify and classify each of them inside one of the creative sectors, as explained below.

In order to identify industries to be used in this analysis, we used the classification by Boix and Lazzeretti (2012), which summarises several classifications of creative industries made by cultural agencies and international expert groups (*e.g.*, the OECD, the WIPO and the UNCTAD, among others). According to this classification, we obtain 17 categories, being a total of 18 if we divided SVE in Software firms (hereafter SOFT) and Videogames and Editing electronics firms (hereafter VGE) in two separate categories (see Table 1).

[INSERT TABLE 1]

As mentioned in the previous sections of the paper, we focus on the Metropolitan Areas (hereafter MA) of Barcelona, Lyon and Hamburg. Concretely, the MA of Barcelona, located in Catalonia, north-eastern Spain, covers an area of 636 km^2, has around 3.2 million inhabitants and includes 36 municipalities, the MA of Lyon (also called *Grand Lyon*) located in Rhône-Alpes, south-eastern France, covers an area of 515 km^2, has around 1.3 million inhabitants and include 59 *communes* (municipalities), and finally the MA of Hamburg, is the biggest metropolitan area subject to this study, covers an area of 2,087 km^2,

[7] SABI and Orbis datasets include several firms' characteristics including year of constitution, balance sheets, income, expenditure accounts, number of employees, industry, sales, assets, and georeferenced location (i.e., X-Y coordinates). SABI and Orbis collect data from Mercantile Register, where all limited liability companies and corporations are obliged by law to deposit their balance sheets. Due to its coverage SABI and Orbis are the most widely used datasets for any country in the world when firm georeferenciation is required.

has around 2.55 million inhabitant and include 37 municipalities.

The main reason to focus on previous metropolitan areas is the large number of SVE's firms located in and around these cities and their metropolitan areas. Concretely the MA of Barcelona contains the 65.02% of the SVE's firms of all Catalonia, for the case of *Grand Lyon*, this contains the 85.26% of the SVE's firms of Rhône-Alpes and finally the MA of Hamburg contains the 85.09% of the SVE's firms in the State of Scheleswig-Holstein, State of Hamburg and Lueneburg District.

Although these cities are clearly the economic and institutional hub of their MA, there are also some spatial heterogeneities at intra-city level that should be controlled. In order to do that, we will analyse location patterns at Barcelona, Lyon and Hamburg using intra-city administrative units (*i.e.*, districts) designed by each City Council.

[INSERT TABLE 2]

Table 2 shows the number of creative firms for each industry sorted by city and MA. It's important to highlight the high number of SVE's firms in all the cities, being the biggest creative sector in terms of number of firms for all the MA (except for Lyon, where Architecture and Engineering has 62 firms more than that of SVE). This fact highlights the importance of this industry inside the Creative industry for these metropolitan areas. Finally, regarding the firm distribution between City-MA, we observe that Barcelona and Hamburg have the most part of their creative firms inside their capital city (74.32% and 82.87% of creative firms inside these capitals, respectively), whilst the city of Lyon has only the 55.81% of the creative firms located in *Grand Lyon*.

3.2. Spatial Methodology

In order to analyse the location patterns of SVE in the MA, we used several techniques including Nearest Neighbour Index (NNI), Kernel densities, K-density Functions and Entropy Index. All these techniques can be used together in order to identify firms' location patterns, because they do not measure exactly the same. While NNI analyses the spatial concentration of points (*e.g.*, firms) in a territory, and does not take into account whether

firms are in different administrative units, Kernel densities give an image of the firm distribution in a territory, observing which are the locations with a high number of firms, K-density functions gives the density of firms using a distance-based approach in order to determine the distribution of bilateral distances between firms from the same activity and/or different activity. Finally, the Entropy Index analyse whether a geographical unit is homogenous or diverse. When used together, these techniques provide us an overall spatial approach for different industries at several levels, and allow to explain locational linkages of SVE's with firms from other industries.

Nearest Neighbour Index (NNI)

The Nearest-Neighbour Index (NNI) (Clark and Evans, 1954) is an indicator that compares the mean of the observed distance between each point (*e.g.*, SVE's firms) and its nearest neighbour with the expected mean distance if a spatial random distribution is assumed. The NNI is formulated as follows:

$$\boldsymbol{NNI = \frac{Observed\ Average\ distance}{Expected\ Average\ distance}}$$

Where Observed Average Distance and Expected Average Distance are defined as:

$$Observed\ Average\ distance = \frac{\sum_{i=1}^{n} d}{n}$$

$$Expected\ Average\ distance = 0.5\sqrt{\frac{A}{n}}$$

, where d is the distance, n is the number of neighbour links and A is the total area of the area considered. Values of NNI can be interpreted as follows: values around 0 indicate a clustered pattern, values around 1 indicate a random distribution, and values higher than 2 indicate an uniform pattern (the maximum possible value is 2.15 for a hexagonal grid). NNI has been used previously (Rehák and Chovanec, 2012) to analyze the location patterns of creative industries in Slovakia.

Kernel density

The Kernel density estimation (used in this paper as a technique for density estimation of the location of firms) is a non-parametric technique where the position of each firm point is smoothed out from that point into the surrounding area around it, defining a radius distance (bandwidth). The aggregation of the individually smoothed contribution of each point gives an overall picture of points' density. Concretely, the bandwidth was defined at 250 meters for the metropolitan case, and at 100 meters for the city case (*i.e.*, only the capital of the MA), zooming in on the distribution of the SVE industry within the city. High values of this density indicate a high concentration of the industry.

K-density Function

K-density Function is a distance-based function developed by Duranton and Overman (2005) that applies a bootstrapping technique in order to determine the bilateral distance between points (firms) in an industry, and to compare it to a set of bilateral distances from all the samples of randomly drawn firms (in our case all firms belonging to creative industries).

Let us define an industry *S* with *n* firms, then we compute a circle distance (*i.e.*, radius) between each pair of firms in that industry, obtaining $n(n-1)/2$ bilateral distances for industry *S*. We denote d_{ij} as the distance in meters between firms *i* and *j*. Finally, the K-density function at any distance *d* is defined as follows:

$$\widehat{K}(d) = \frac{1}{n(n-1)h} \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} f\left(\frac{d - d_{ij}}{h}\right)$$

, where *h* is the optimal bandwidth, and *f* is a Gaussian kernel function, where all densities are calculated. It's relevant to mention that an employment-weighted version of the *K*-density exists, but in this paper we are not using it[8]. This function will be used at intra

[8] The employment-weighted version of the *K*-density function is not used because our research question, which focuses on the location and colocation of the Software and Videogames industry inside metropolitan areas, only considers the location of the firm, not its employment size.

industry and inter industry approaches, analysing in the first the density of firms (bilateral firm distances) of an industry and comparing it with the density of the whole creative activity, while in the second analyses the bilateral distance between a pair of industries also comparing it with the density of the whole creative activity. High (low) values at a radius value will indicate a high (low) density of firms at this radius. K-density Function has been used in numerous papers in order to analyse the density of firm for each distance and how firms agglomerate (*i.e.* Behrens *et al.,* 2016, use this technique to analyse resilience of the Canadian textile industry).

Entropy Index

The entropy index (ENTRO) is another widely used indicator of inequality (Theil 1972). ENTRO index ranges between 0 and 1 and is typically used to detect whether a spatial unit (*e.g.*, a city district in this paper) is homogenous or diverse. In this case we apply the entropy index to the diversity of creative industries at city district level for the capitals of the three metropolitan areas considered (10 for Barcelona, 9 for Lyon and 7 for Hamburg). Concretely, values close to 0 indicate that there is a predominant creative industry at the considered district, whilst values close to 1 indicate that there is no a predominant creative industry (i.e., industrial diversity is high).

4. The metropolitan location of the Software industry: some results

4.1 Kernel density and Nearest Neighbour Index

Kernel density

Kernel density results (figures 2, 3 and 4) indicate a general spatial concentration of the creative firms at metropolitan and city levels and at city levels. Regarding SVE industry, by contrast, tend to be cluster inside some parts of the city centre, to be discussed below.

[INSERT FIGURE 2]

Figure 2 shows the spatial pattern of the aforementioned industries for the MA of Barcelona

(hereafter MAB). It is important to note the existence of natural spatial discontinuities inside the MAB[9]. As shown on the map, there is a big concentration of creative industries inside Barcelona and the municipalities belonging to the MA but if only SVE's firms are considered, then almost all of them locate in three areas of the city of Barcelona: Diagonal avenue, and Eixample and 22@ (Poblenou) districts. Concretely, this is a polycentric pattern in which there is a huge number of firms at some central areas of the city at the same time that a similar number is located in high-tech neighbourhoods, a situation that is increasingly frequent in western big metropolitan areas, as showed for Barcelona (Méndez-Ortega and Arauzo-Carod, 2017) and Toronto, Montreal and Vancouver (Duvivier and Polèse, 2017; Duvivier *et al.*, 2017).

[INSERT FIGURE 3]

Figure 3 shows the spatial pattern for the MA of Lyon (also called *Grand Lyon*). In a similar way than in Barcelona, creative activities locate around all the MA but they agglomerate in the city of Lyon, specially for SVE's firms. It is worth mentioning that SVE's firms do not agglomerate in the *Confluence* zone, inasmuch as these firms are located in the most central areas of the city (CBD). We assume that these firms may tend to be close to traditional core areas in order to get sufficient accessibility to skilled workers, institutions, creativity and social relationships, creating places with a high variety of industries (Hutton, 2004). In this sense, there is the example of New York, where after the recent financial crisis, creative industries replaced finance as an economic driver inside the city (Indegaard, 2009, 2013) and also the case of London, Vancouver and Singapore, where the collapse of Fordist production inside city centres produced a realignment of the metropolis core (Hutton, 2006, 2009).

[INSERT FIGURE 4]

Finally, Figure 4 shows the spatial concentration for the MA of Hamburg. In a similar way

[9] The city of Barcelona is bounded by the Mediterranean Sea in the east and by a wooded mountain area (Collserola) in the north-northwest between Barcelona and the North-Western municipalities.

than for Barcelona and Lyon, whilst creative industries locate across the whole MA, SVE's firms tend to concentrate inside the city of Hamburg and, concretely, in *HafenCity* quarter.

To sum up previous results, kernel densities suggest that there are three slightly different industry location patterns, one for each metropolitan area considered: *i)* in Barcelona there is a polycentric structure of SVE's firms as there are some subcentres in core areas and at the urban renewal area (22@); *ii)* in Lyon SVE's firms concentrate around city centre, but not in the urban renewal area (*Confluence*); and *iii)* in Hamburg, there is a clear concentration at the urban renewal area (*HafenCity*).

Nearest Neighbour Index

NNI values shown in Table 3 provide an overview of clustering of *i)* all Creative Industries, *ii)* SVE's industries, *iii)* SOFT industries and *iv)* VGE industries. For the sake of simplicity we will focus our analysis on SOFT and VGE industries for both metropolitan areas and capitals of these areas.

[INSERT TABLE 3]

Location patterns of aforementioned spatial areas and industries have important specificities according to these two dimensions but, specially, in terms of industries. In this sense, NNI values are much higher for VGE industries than for SOFT ones (i.e., clusterisation is stronger for SOFT industries), but for three metropolitan areas and cities they are pretty similar. Concretely, SOFT industries range from 0.332 to 0.365 at metropolitan level and from 0.300 and 0.391 at city level, whilst higher values for VGE range between 0.517 and 1.971 (metropolitan areas), and between 0.595 and 0.698 (cities).

In general terms SOFT industries have a similar clusterisation level across all metropolitan areas and cities, but a further analysis allows to identify two slightly different patterns. The first one corresponds to Barcelona and Lyon, where clusterisation is higher for their metropolitan areas than for the city capitals, whilst the second one corresponds to Hamburg, where the situation is exactly the opposite. Obviously spatial scope of respective

metropolitan areas matters as, for instance, quotients (e.g., in terms of population or jobs) between city capital and their metropolitan areas differ but, nevertheless, it is also obvious that this result illustrates some location specificities across these areas.

Results for VGE industries are not easy to analyse as number of firms is quite low compared to that of SOFT firms (127 vs. 3019 in Barcelona, 254 vs. 1656 in Lyon, and 50 vs. 4506 in Hamburg) and also because spatial distribution of firms adjusts clearly to a CBD pattern as most of them locate at city capital instead of at the metropolitan area: Hamburg (90% of VGE firms locate at the capital), Barcelona (82%), and Lyon (56%). This is why results for VGE at metropolitan area level are less reliable in view of the small number of firms (e.g., 22 firms in Barcelona and 5 firms in Hamburg). If we focus on city level, then results indicate a lower clusterisation level (0.698 for Barcelona, 0.595 for Lyon and 0.675 for Hamburg) that even positive, suggests the existence of other location factors apart from physical proximity among firms of the same industry.

4.2 *K*-density Function

In next following graphs (see Figures 5, 6, 7 and 8) we show the *K*-density function of the SVE for the Metropolitan Areas of Barcelona, Lyon and Hamburg and the relationship between SVE's firms and some creative sectors[10].

Intra-Industry Analysis

Figure 5 shows firm density for SVE at city and metropolitan level. At first glance it is possible to check that density of these industries differs across cities, presenting a similar pattern for Barcelona and Hamburg, and a completely different distribution for Lyon. SVE's firms have a similar concentration pattern almost identical to all creative sectors, expect for Hamburg, where SVE industry is more concentrated than all the creative in the first tram of the radius (0-10,000 meters).

[INSERT FIGURE 5]

[10]All calculations were made at a 0.05 significance level, using 1000 simulations. The dashed line is the density of all the economic activity (All Creative firms in our case) and the shaded area is the confidence interval.

Inter-Industry Analysis

In the following figures the relationship between SVE's firms with other high-tech creative firms will be compared.

[INSERT FIGURE 6]

[INSERT FIGURE 7]

[INSERT FIGURE 8]

When the *K*-density between SVE vs VFI firms is compared, we observe that this pair of industries tend to be more concentrated than the whole creative sectors in a first tram of the radius for all the cities, indicating that these industries tend to locate close each other; the same happens with SVE vs ADV and SVE vs RTV as well, giving a *K*-density value higher than the whole creative sectors in the first tram of the radius for all the cities. In contrast, for the SVE vs GA case, we observe the opposite effect, since these sectors are less agglomerated than the whole creative sectors in a first tram of the radius for all the cities.

Summarizing, these results support the role of intra-urban agglomeration of the SVE industry in economic activity, especially with other high-tech firms. These results show that Software firms tend to locate close to core locations, at least in these cities. These results are in line with Duvivier and Polèse (2017), where it is shown that high tech firms tend to be located near other creative industries such as Arts-related occupations and Financial Institutions.

4.3 Entropy analysis.

Finally, Entropy Index (*E*) provides a different approach about spatial / industrial heterogeneity as it allows to identify whether a spatial unit (*e.g.*, city district or municipality) is homogeneous or diverse. Concretely, *E* ranges between 0 and 1, being that values close to 0 indicate that in this area there is a predominant industry, and values close to 1 indicate that relative weights of each activity are similar. In this sense, figures 9, 10 and 11 show that, in general terms, core areas of three capitals are those with higher entropy levels, i.e. those with a more diverse composition of activities, being that peripheral areas tend to rely on

lower number of industries.

[INSERT FIGURE 9]

[INSERT FIGURE 10]

[INSERT FIGURE 11]

Additionally, in order to try to identify drivers of entropy we have included number of firms at district / municipality level and, as expected, entropy is higher when there are a large number of firms. Concretely, high tech firms tend to locate close to places where values as tolerance, diversity and skilled human capital act as drivers of high technology entrepreneurship (Qian, 2013). Finally, these are places where creativity and multicultural environment provide an important stimulus to these firms in terms of innovation and growth (Florida and Gates, 2003).

5. Conclusions

In this paper we have analysed whether location strategies of SVE's firms share similar strategies across a sample of three European cities and metropolitan areas (Barcelona, Lyon and Hamburg) where these activities are of high importance at regional level. We have focused on this industry according to its growing importance, its specificities as a high-tech creative industry, its strategic role in terms of city marketing and knowledge generation and the potential higher European competitiveness in view of technological and human capital requirements of firms from SVE's.

Our preliminary results strongly show the existence of intra-urban agglomeration in economic activity, especially when dealing with creative industries. More specifically, these results indicate that although in Europe software firms typically tend to locate close to core locations, there are (at least) three models that may be easily identified when comparing location patterns of Software and Videogames (SVE) industry and Videogames (VGE) industry with those of all creative industries at city/metropolitan level: the first one consists on a strong concentrated pattern (Hamburg), the second one consists on an intermediate (polycentric) agglomeration pattern (Barcelona) and the third one consists on a moderate

agglomeration (*intramuros*) pattern (Lyon). Obviously, these differences are triggered by specific local policies, urban structures, path dependence on previous spatial configuration of economic activity, and general city and metropolitan characteristics, but in general terms they confirm that there is no a single agglomeration strategy to be followed by creative industries, which also implies that different policies may be provided according to specificities of each metropolitan area. In this regard, one of main goals of policy makers should be the ex-ante identification of agglomeration preferences of these industries for a given metropolitan area, in order to decide whether to increase or not existent agglomerations.

Overall, our results should be interpreted with care due to some potential limitations that we aim to solve in future research. Firstly, they correspond to a specific period of time and, therefore, may be biased due to different business cycle at city level[11]. Secondly, they refer to only three cities and metropolitan areas, and may include some city-specific effects not operating in other areas. Thirdly, they may be biased due to criteria used in order to identify metropolitan areas to be considered around each one of three main cities. Fourthly, they come from an overall analysis of firms from SVE's industry without taking into account whether differences in firms' size across the three metropolitan areas may imply as well some differences in location and agglomeration patterns. Further research should explore all these issues in order to provide more robust results.

Acknowledgements:

This article has benefited from funding from ECO2017-88888-P, the "Xarxa de Referència d'R+D+I en Economia i Polítiques Públiques" and the research programme SGR (2017 SGR 159). We are grateful for the support received by R. Boix and A. Moreno and for the comments received at 30th ERSA Summer School, 6th Central European Regional Science Conference, XLIII International Conference on Regional Science and the 4th Geography of Innovation Conference. Any errors are, of course, our own.

[11]As a matter of example, in recent crisis contraction of economic activity started early in Barcelona and its duration has been longer than in Lyon and Hamburg.

References:

Apparicio, P.; Martori, J.C.; Pearson, A.L.; Fournier, E. and Apparicio, D. (2014): "An open-source software for calculating indices of urban residential segregation", *Social Science and Computer Review* 32 (1): 117-128.

Autor, D.H.; Levy, F. and Murnane, R.J. (2003): "The Skill Content of Recent Technological Change: An Empirical Exploration", *Quarterly Journal of Economics* 118 (4), 1279-1333.

Bagwell, S. (2008). Creative clusters and city growth. *Creative Industries Journal*, 1(1), 31-46.

Behrens, K., Boualam, B., & Martin, J. (2016). *The resilience of the Canadian textile industries and clusters to shocks, 2001-2013*. CIRANO.

Berger, T. and Frey, C.B. (2015): "Did the Computer Revolution Shift the Fortunes of U.S. Cities? Technology shocks and the geography of new Jobs", *Regional Science and Urban Economics* (57), 38–45.

Boekholt, P. and Thuriaux, B. (1999): "Public policies to facilitate clusters: Background, rationale and policy practices in international perspective". In: OECD (ed.) *Boosting innovation: The cluster approach*. OECD: Paris.

Boix, R. and Lazzeretti, L. (2012). Las industrias creativas en España: Una panorámica. *Investigaciones Regionales*, (22), 181–205.

Coll-Martínez, E., Moreno-Monroy, A. I., & Arauzo-Carod, J.-M. (2017). Agglomeration of Creative Industries: An Intra-metropolitan Analysis for Barcelona, *Papers in Regional Science*, forthcoming.

Clark, P. J. and Evans, F. C. (1954). Distance to nearest neighbor as a measure of spatial relationships in populations. *Ecology*, 35(4), 445-453.

Duranton, G. and Overman, H. G. (2005). Testing for Localization Using Micro-Geographic Data. *The Review of Economic Studies*, 72(4), 1077–1106.

Dutta, S. and Mia, I. (2010). The global information technology report 2009 – 2010 ICT for Sustainability. *World Economic Forum*.

Duvivier, C., and Polèse, M. (2017). The great urban techno shift: Are central neighbourhoods the next silicon valleys? Evidence from three Canadian metropolitan areas. *Papers in Regional Science,* forthcoming.

Duvivier, C., Polèse, M., and Apparicio, P. (2017). The location of information technology-led new economy jobs in cities: office parks or cool neighbourhoods?. *Regional Studies*, forthcoming.

Feldman, M.; Francis, J. and Bercovitz, J. (2005): "Creating a cluster while building a firm: Entrepreneurs and the formation of industrial clusters", *Regional Studies* 39, 129-141.

Florida, R., and Gates, G. (2003). Technology and tolerance: The importance of diversity to high-technology growth. In *The city as an entertainment machine* (pp. 199-219). Emerald Group Publishing Limited.

Florida, R., and Mellander, C. (2016). Rise of the startup city: the changing geography of the venture capital financed innovation. *California Management Review*, 59(1), 14-38.

Foord, J. (2013). The new boomtown? Creative city to Tech City in east London. *Cities*, 33, 51-60.

Fromhold-Eisebith, M. and Eisebith, G. (2005): "How to institutionalize clusters? Comparing explicit top-down and implicit bottom-up approaches", *Research Policy* 34: 1250-1268.

Globerman, S.; Shapiro, D. and Vining, A. (2005). Clusters and intercluster spillovers: Their influence on the growth and survival of Canadian information technology firms. *Industrial and Corporate Change* (14), 27–60.

Hutton, T. A. (2004). The new economy of the inner city. *Cities*, 21(2), 89-108.

Hutton, T. A. (2006). Spatiality, built form, and creative industry development in the inner city. *Environment and Planning A*, 38(10), 1819-1841.

Hutton, T. A. (2009). Trajectories of the new economy: Regeneration and dislocation in the inner city. *Urban Studies*, 46(5-6), 987-1001.

Indergaard, M. (2009). What to make of New York's new economy? The politics of the creative field. *Urban Studies*, 46(5-6), 1063-1093.

Indergaard, M. (2013). Beyond the bubbles: Creative New York in boom, bust and the long run. *Cities*, 33, 43-50.

Malmberg, A. and Maskell, P. (2002): "The elusive concept of localization economies: Towards a knowledge-based theory of spatial clustering", *Environment and Planning A*, 34, 429–449.

Malmberg, A. and Maskell, P. (2006): "Localized learning revisited", *Growth and Change* (37), 1–18.

Méndez-Ortega, C. and Arauzo-Carod, J.M. (2017): "Location of the Software & Videogames Industry: an insight into the case of Barcelona using microgeographic data", *Working Paper CREIP* 3-2017.

Morgan, K. (2004). The exaggerated death of geography: learning, proximity and territorial innovation systems. *Journal of Economic Geography*, 4(1), 3-21.

Moriset, B. (2003): "The New Economy in the City: Emergence and Location Factors of Internet-based Companies in the Metropolitan Area of Lyon, France", *Urban Studies* 40 (11), 2165-2186.

Murphy, E.; Fox-Rogers, L. and Redmond, D. (2015): "Location Decision Making of "Creative" Industries: The Media and Computer Game Sectors in Dublin, Ireland", *Growth and Change* 46 (1), 97–113.

Oliva, A. (2004): *The 22@ bcn activities district. Barcelona Model*. Management Booklets 15. Aula Barcelona: Barcelona.

Pratt, A. C. (2009). Urban regeneration: From the artsfeel good'factor to the cultural economy: A case study of Hoxton, London. *Urban studies*, 46(5-6), 1041-1061.

Qian, H. (2013). Diversity versus tolerance: The social drivers of innovation and entrepreneurship in US cities. *Urban Studies*, 50(13), 2718-2735.

Rantisi, N. M., & Leslie, D. (2010). Materiality and creative production: the case of the Mile End neighborhood in Montréal. *Environment and Planning A*, 42(12), 2824-2841.

Rehák, Š. and Chovanec, M. (2012). Exploring Spatial Patterns of Creative Industries with Firm Level Micro Geographic Data. *Region Direct* (2), 10–35.

Suire, R. and Vicente, J. (2009): "Why do some places succeed when others decline? A social interaction model of cluster viability", *Journal of Economic Geography* 9, 381–404.

Theil, H. (1972): *Statistical Decomposition Analysis*, North-Holland: Amsterdam.

UNCTAD (2010): *Creative economy. Report 2010*. UNCTAD, Geneva.

Viladecans-Marsal, E. and Arauzo-Carod, J. M. (2012): "Can a knowledge-based cluster be created? The case of the Barcelona 22@ district", *Papers in Regional Science* 91(2), 377–400.

TABLES:

Table 1: List of creative industries classification

Nº	Creative industries	Acronym	NACE 2009 Codes
1	Advertising and related services	ADV	731
2	Architecture and engineering	AE	711
3	Art and antiques trade	ART	4779
4	Craft and Performing Arts	CPA	90
5	Cultural Tourism and Recreational Services	TRS	93
6	Publishing	ED	581
7	Fashion	FA	14, 1511, 152
8	Graphic arts	GA	181
9	Heritage, cultural sites and recreational services	HE	91
10	Creative research and development	IDC	721, 722
11	Jewellery, musical instruments, toys and games	JEW	321, 322, 324
12	Music and music studies	MU	182, 592
13	Photography	PHO	742
14	Radio and TV	RTV	601, 602
15	Software, videogames and editing electronics	SVE	620, 582
	15.1 Software Firms	SOFT	620
	15.2 Videogames and Editing electronics Firms	VGE	582
16	Specialised services design	SSD	741
17	Video and film industries	VFI	591

Source: Compiled by the authors.

Table 2: Number of Creative industries at city and Metropolitan Area level.

		Barcelona			Lyon			Hamburg		
Nº	**CI Acronyms**	**City**	**MA**	**Total**	**City**	**MA**	**Total**	**City**	**MA**	**Total**
1	**ADV**	1924	367	2291	379	260	639	1479	226	1705
2	**AE**	2091	734	2825	1039	933	1972	1816	488	2304
3	**ART**	69	19	88	80	49	129	63	12	75
4	**CPA**	468	99	567	99	77	176	269	29	298
5	**TRS**	767	372	1139	119	138	257	1233	399	1632
6	**ED**	930	172	1102	125	65	190	514	85	599
7	**FA**	422	379	801	85	32	117	134	21	155
8	**GA**	869	675	1544	101	138	239	503	183	686
9	**HE**	41	10	51	0	2	2	58	10	68
10	**IDC**	225	93	318	97	88	185	272	67	339
11	**JEW**	141	42	183	93	38	131	82	17	99
12	**MU**	160	43	203	36	19	55	349	37	386
13	**PHO**	226	67	293	31	47	78	105	14	119
14	**RTV**	146	30	176	33	4	37	48	1	49
15	**SVE**	2346	801	3147	1046	864	1910	3810	746	4556
15.1	**SOFT**	*2241*	*779*	3020	*903*	*753*	1656	3765	741	3770
15.2	**VGE**	*105*	*22*	127	*143*	*111*	254	45	5	50
16	**SSD**	317	84	401	105	57	162	277	25	302
17	**VFI**	768	127	895	181	78	259	662	52	714
	Total	11910	4114	16024	3649	2889	6538	11674	2412	14086

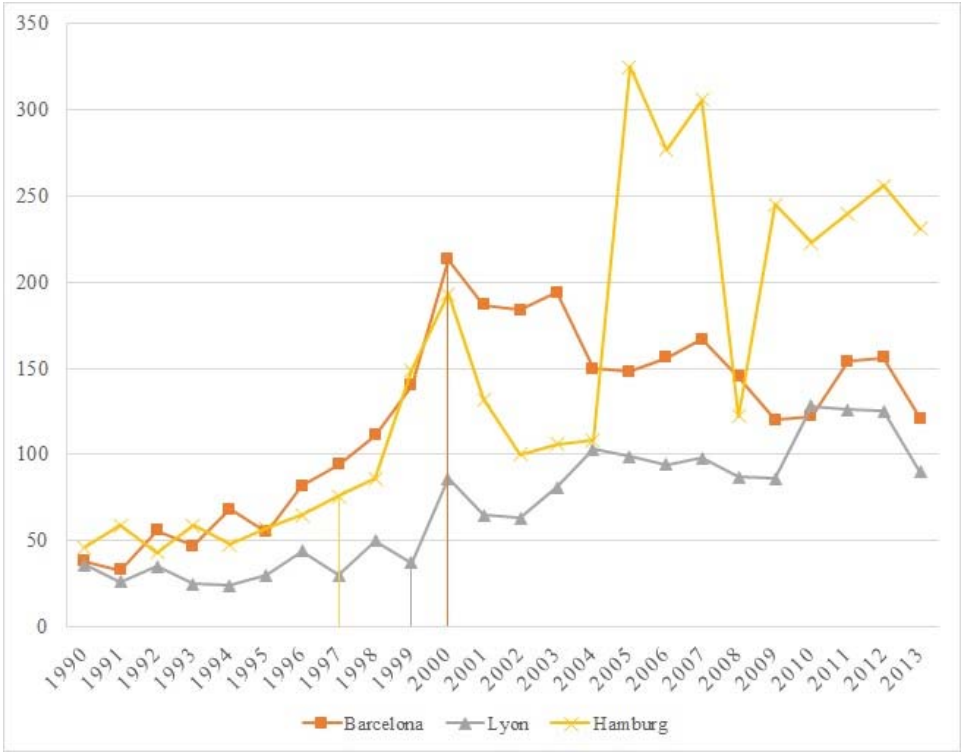
Note: Creative industry acronyms can be found at Table 1. City refers to firms inside the city and MA refers to firms inside the Metropolitan Area.
Source: Compiled by the authors.

Table 3: Nearest Neighbour Index from Creatives, Software and Videogames Industry in Barcelona, Lyon and Hamburg (at City and Metropolitan Area level).

Barcelona	Metropolitan Area + City				Metropolitan Area				City			
	All creative	**SVE**	**SOFT**	**VGE**	**All creative**	**SVE**	**SOFT**	**VGE**	**All creative**	**SVE**	**SOFT**	**VGE**
AOD	35.661	91.262	93.688	505.944	80.245	205.367	208.282	1727.942	21.466	53.202	54.250	299.941
AED	140.815	311.768	318.258	1264.721	277.891	617.867	626.531	3038.681	77.782	136.516	139.679	429.999
NNI	0.253	0.293	0.294	0.400	0.289	0.332	0.332	0.569	0.276	0.390	0.388	0.698
N. Observations	16022	3146	3019	127	4114	801	779	22	11908	2345	2240	105
Z-Value	-180.827	-75.893	-74.171	-12.935	-87.273	-36.147	-35.644	-3.871	-151.148	-56.537	-55.377	-5.929
Lyon	**Metropolitan Area + City**				**Metropolitan Area**				**City**			
	All creative	**SVE**	**SOFT**	**VGE**	**All creative**	**SVE**	**SOFT**	**VGE**	**All creative**	**SVE**	**SOFT**	**VGE**
AOD	62.760	125.563	146.435	424.911	112.659	209.067	245.280	688.531	25.529	60.851	69.595	225.056
AED	254.400	421.785	452.979	879.705	382.677	627.121	671.755	1330.738	93.917	165.509	178.133	378.060
NNI	0.247	0.298	0.323	0.483	0.294	0.333	0.365	0.517	0.272	0.368	0.391	0.595
N. Observations	6537	1910	1656	254	2889	864	753	111	3648	1046	903	143
Z-Value	-116.517	-58.718	-52.684	-15.763	-72.555	-37.486	-33.328	-9.727	-84.138	-39.124	-35.028	-9.259
Hamburg	**Metropolitan Area + City**				**Metropolitan Area**				**City**			
	All creative	**SVE**	**SOFT**	**VGE**	**All creative**	**SVE**	**SOFT**	**VGE**	**All creative**	**SVE**	**SOFT**	**VGE**
AOD	88.646	174.253	175.126	3234.097	220.666	460.218	464.358	24600.318	62.262	122.404	122.394	1799.817
AED	320.268	558.072	561.160	4069.431	773.960	1379.154	1383.799	12478.974	238.434	411.866	408.112	2666.606
NNI	0.277	0.312	0.312	0.795	0.285	0.334	0.336	1.971	0.261	0.297	0.300	0.675
N. Observations	14086	4556	4506	50	2412	746	741	5	11674	3810	3765	45
Z-Value	-164.207	-88.809	-88.342	-2.777	-67.167	-34.816	-34.601	4.155	-152.725	-82.991	-82.181	-4.171

Note: AOD (Average Observed distance), AED (Average Expected Distance), NNI (Nearest Neighbour Index), SVE (Software, Videogames and Editing Electronics), SOFT (Software), and VGE (Videogames and Editing Electronics). All distances are in metres.
Source: Compiled by the authors.

Figure 1: SVE's firm's entries by year at Barcelona, Lyon and Hamburg at Metropolitan level.

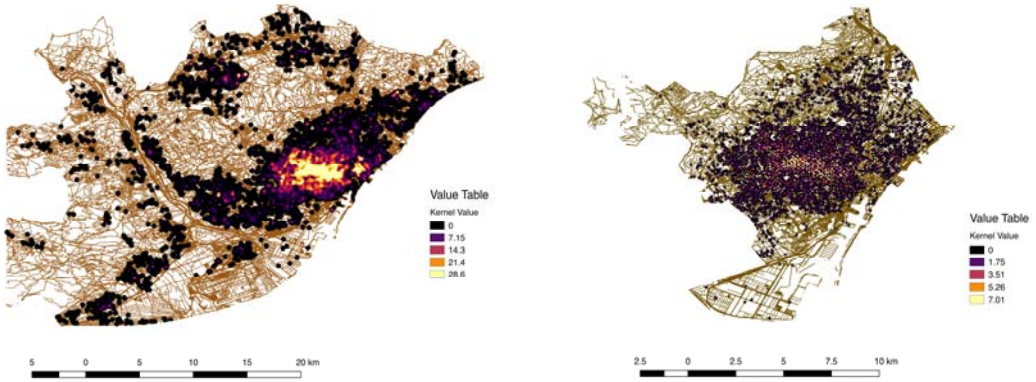


Note: The vertical lines represent the announcement year of each urban renewal project (2000 for Barcelona, 1999 for Lyon and 1997 for Hamburg).

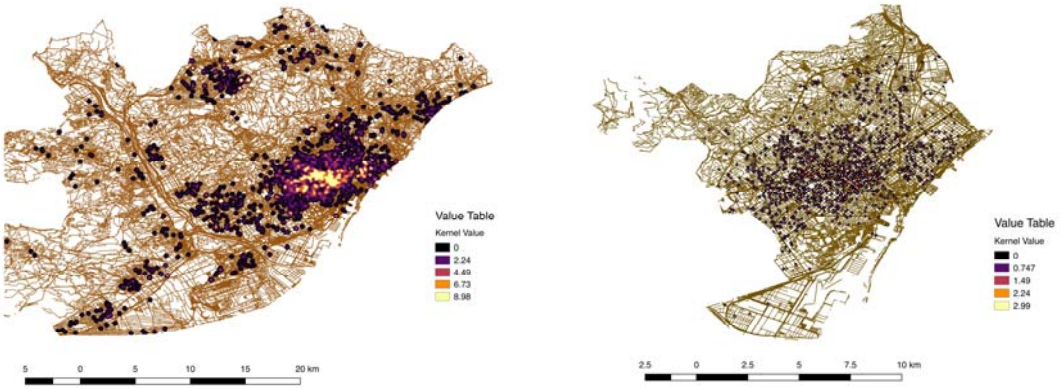
Figure 2: Kernel density for Barcelona at Metropolitan and City Scale.

Metropolitan Area City

All Creative firms



Software, Videogames and Editing Electronics

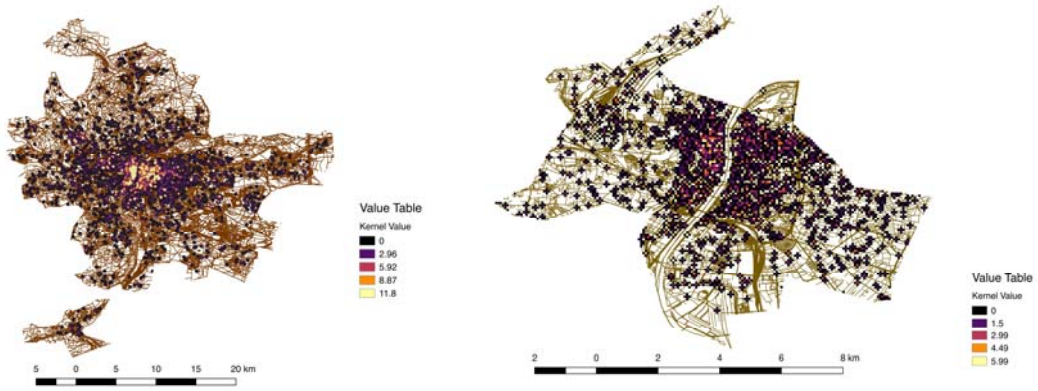


Note: The chosen bandwidth at Metropolitan level is 250 meters and 100 at city level. Source: Compiled by the authors.

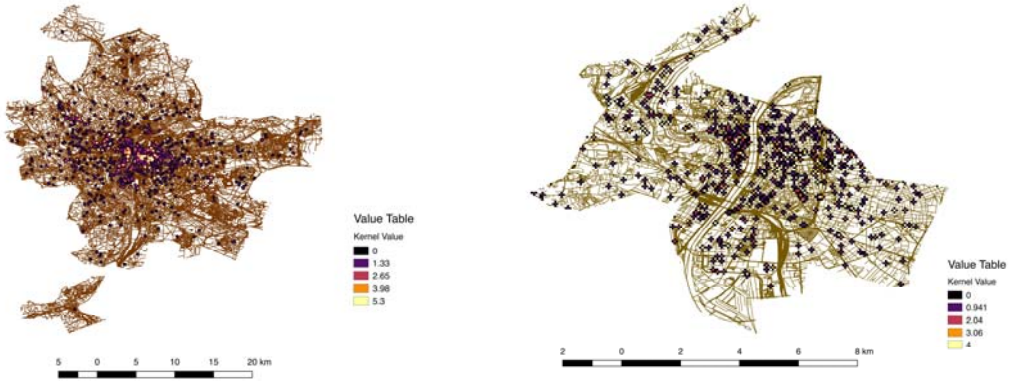
Figure 3: Kernel density for Lyon at Metropolitan and City Scale

Metropolitan Area City

All Creative firms



Software, Videogames and Editing Electronics

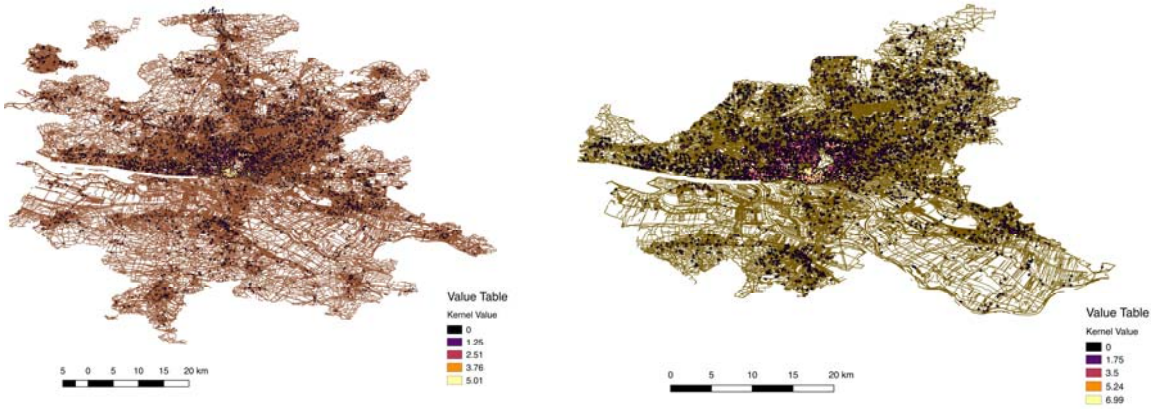


Note: The chosen bandwidth at Metropolitan level is 250 meters and 100 at city level. Source: Compiled by the authors.

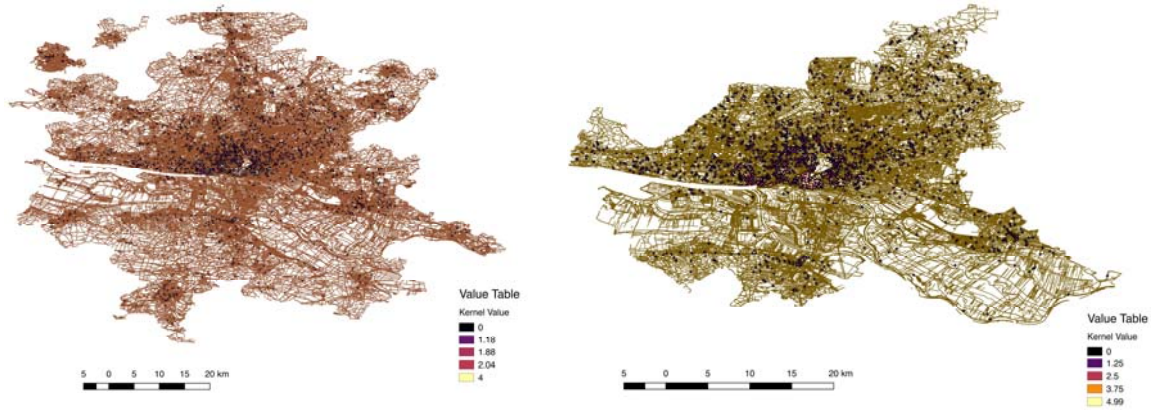
Figure 4: Kernel density for Hamburg at Metropolitan and City Scale

Metropolitan Area City

All Creative firms



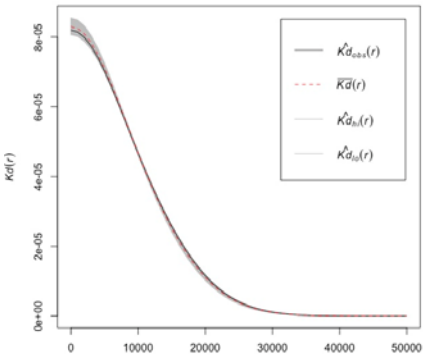
Software, Videogames and Editing Electronics



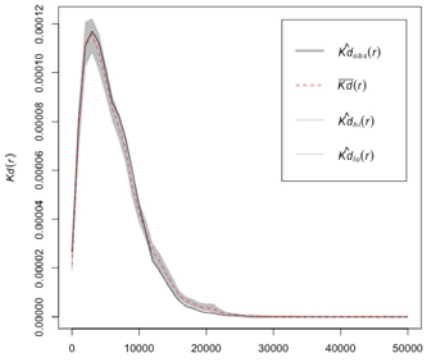
Note: The chosen bandwidth at Metropolitan level is 250 meters and 100 at city level. Source: Compiled by the authors.

Figure 5: Kd Function of SVE for the Metropolitan Areas of Barcelona, Lyon and Hamburg.

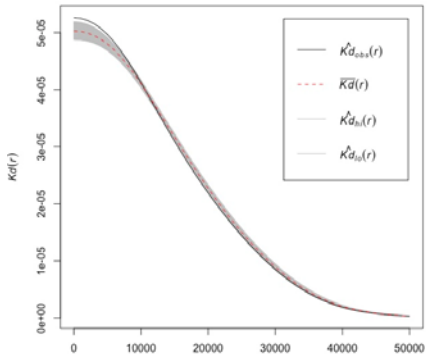
Metropolitan Area of Barcelona



Metropolitan Area of Lyon

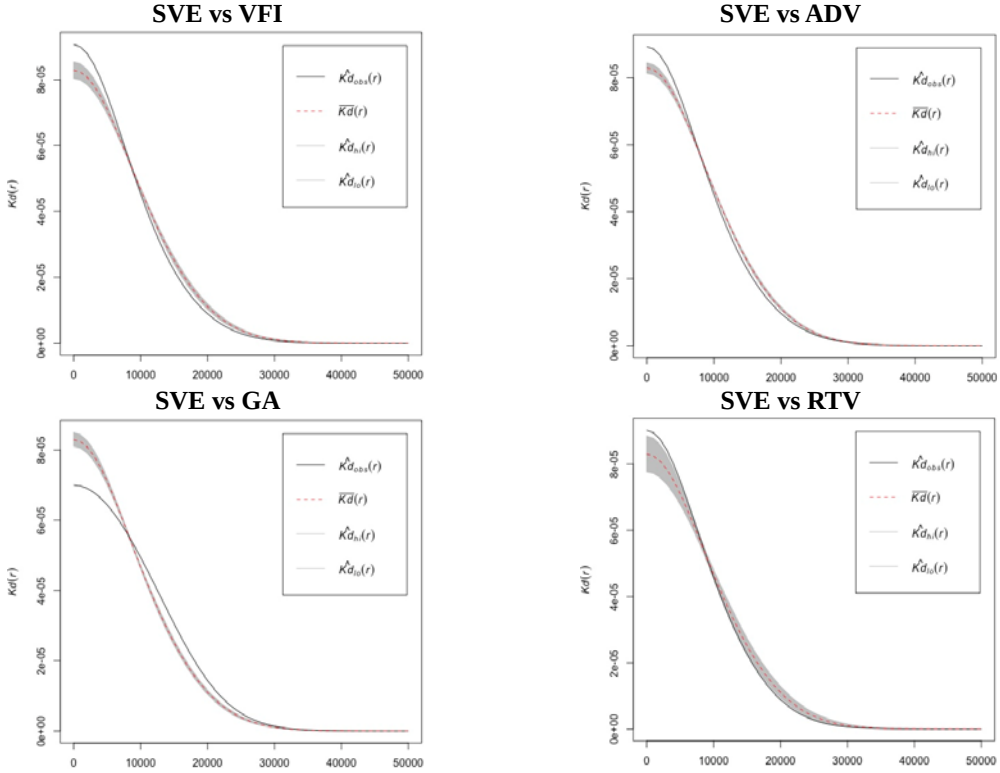


Metropolitan Area of Hamburg



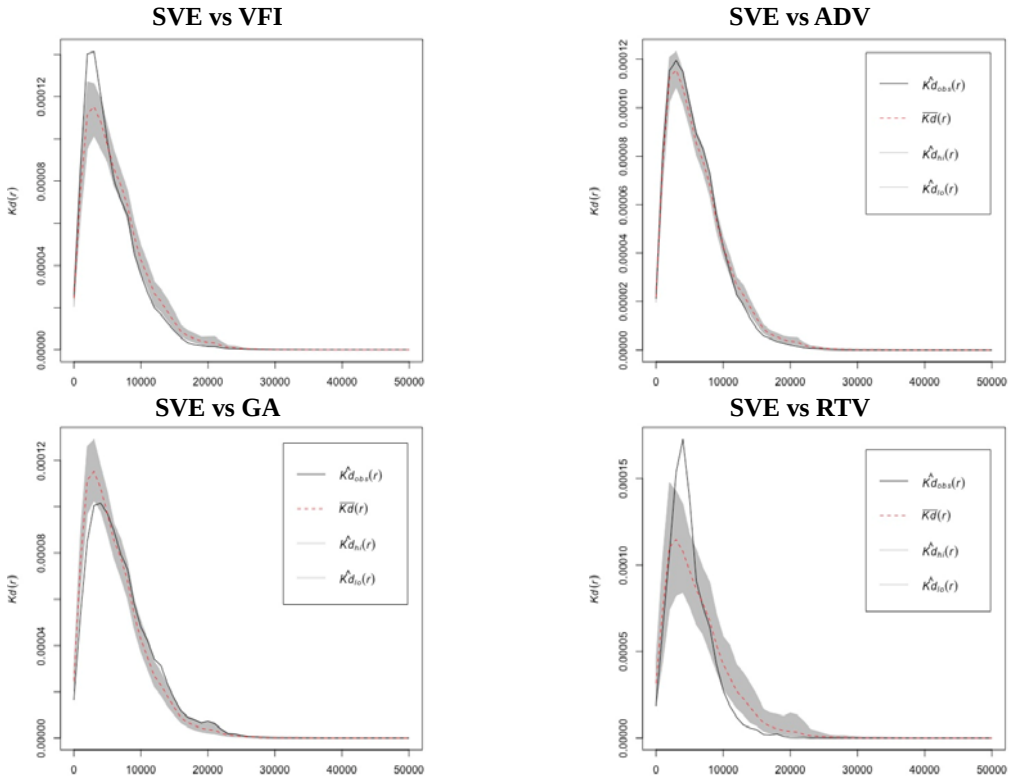
Horizontal axis units (r): meters. Source: Compiled by the authors.

Figure 6: Kd Function of SVE vs. some Creative sectors for the Metropolitan Area of Barcelona.



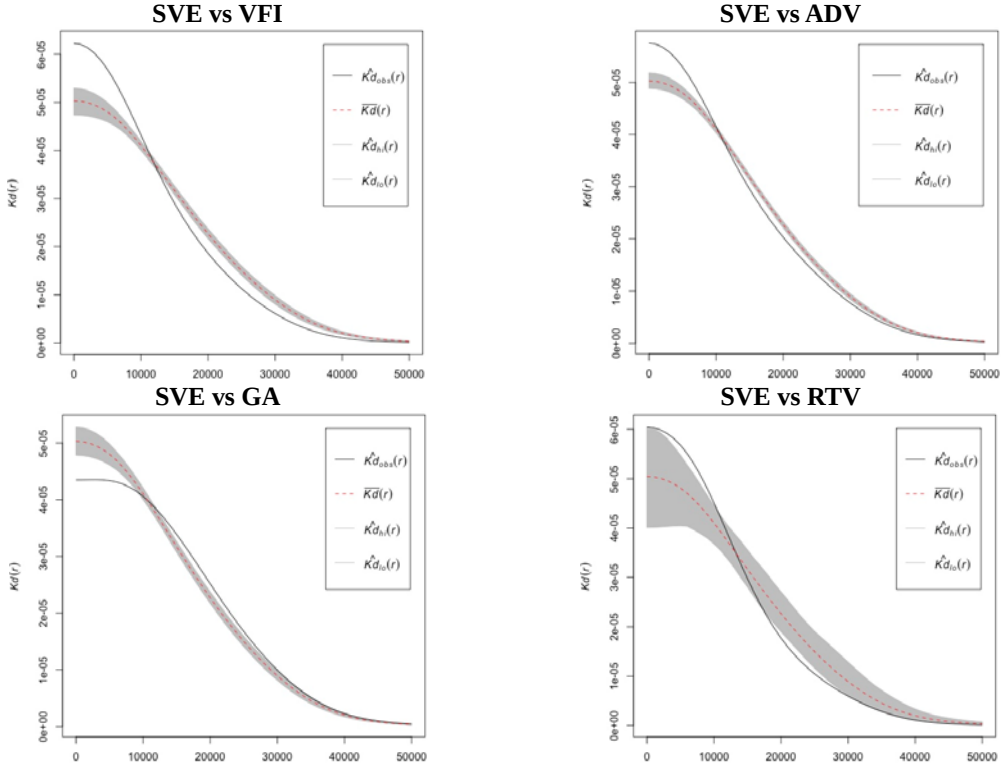
Horizontal axis units (r): meters. Source: Compiled by the authors.

Figure 7: Kd Function of SVE vs. some Creative sectors for the Metropolitan Area of Lyon.



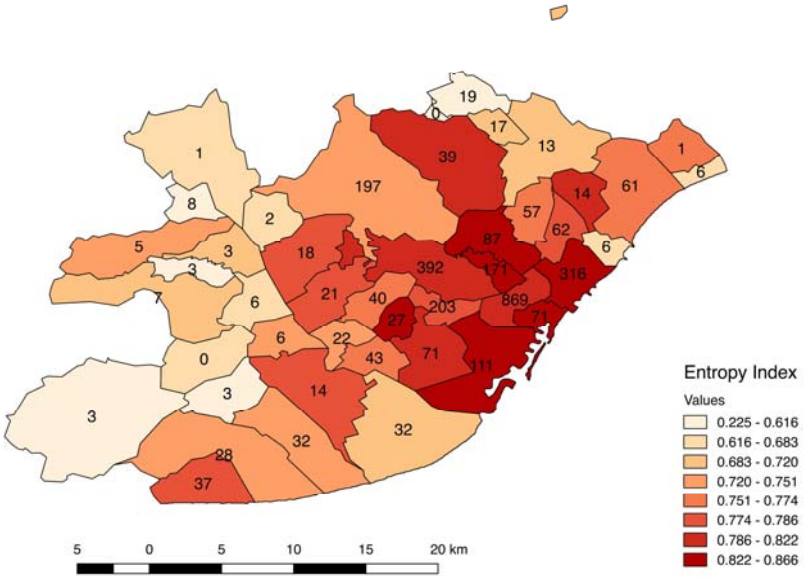
Horizontal axis units (r): meters. Source: Compiled by the authors.

Figure 8: Kd Function of SVE vs. some Creative sectors for the Metropolitan Area of Hamburg.



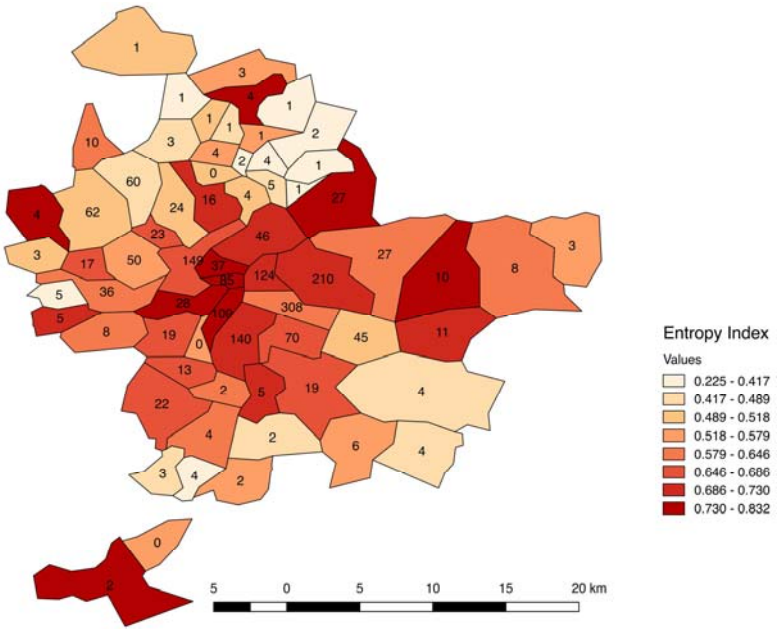
Horizontal axis units (r): meters. Source: Compiled by the authors.

Figure 9: Entropy Index and number of SVE Firms by region in the Metropolitan Area of Barcelona.



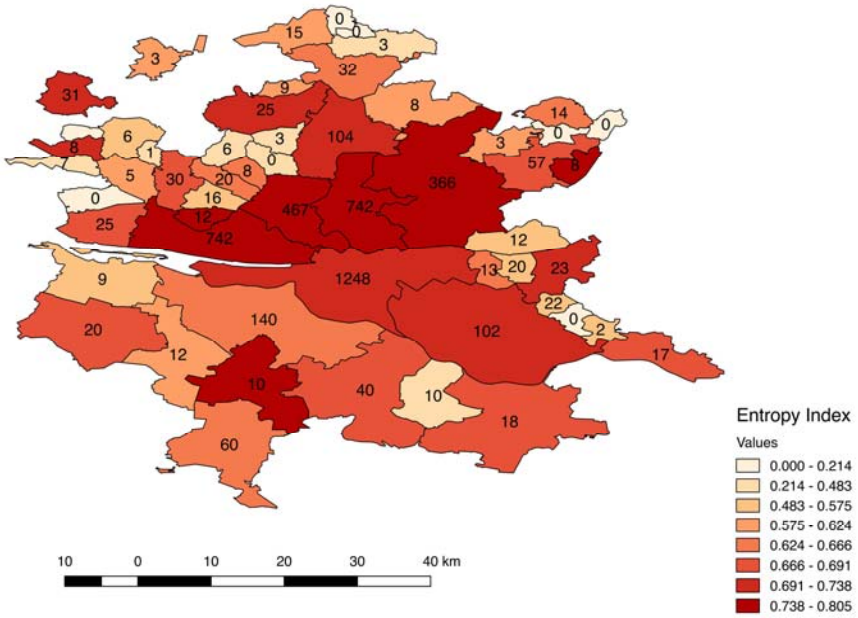
Note: Regions are municipalities and Barcelona city districts (10).
Source: Compiled by authors using Geo-Segregation Analyzer (Apparicio *et al*., 2014).

Figure 10: Entropy Index and number of SVE Firms in the Metropolitan Area of Lyon.



Note: Regions are municipalities and Lyon city districts (9).
Source: Compiled by authors using Geo-Segregation Analyzer (Apparicio *et al*., 2014).

Figure 11: Entropy Index and number of SVE Firms in the Metropolitan Area of Hamburg.



Note: Regions are municipalities and Hamburg city districts (7).
Source: Compiled by authors using Geo-Segregation Analyzer (Apparicio *et al*., 2014).