Location of the Software & Videogames Industry: an insight into the case of Barcelona using microgeographic data*

Carles Méndez-Ortega (♣): carles.mendez@urv.cat
Josep-Maria Arauzo-Carod (♣): josepmaria.arauzo@urv.cat

Abstract

This paper analyses location patterns of Software and Videogames industries in the Metropolitan Area of Barcelona using microgeographic data. These industries benefit from agglomeration economies, skilled labour and, generally speaking, spillover effects, and tend to cluster in larger metropolitan areas, but less is known about their detailed location patterns inside these areas. We contribute to the empirical literature by identifying how Software and Videogames industries firms are concentrated in some core areas of the metropolitan area. Our empirical application includes using the Nearest Neighbour Index (NNI) and M-functions, as well as local spatial autocorrelation indicators.

JEL Codes: R12, C60, L86

Keywords: Software Industry, Videogames Industry, microgeographic data, spatial location patterns, Barcelona

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

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1. Motivation

The software industry means computer programs or data (stored bits and bytes), which can be stored electronically and used by computer processors to perform various tasks. This industry has transformed the way in which organizations, firms and workers are coordinated and behave, and its impact on the global economy can be measured by the increased rate of technical progress, enhanced productivity and continuous innovations.

The software industry has gone from a position of obscurity to indispensability in less than fifty years. The industry emerged in the mid-1970s as part of the Computer Revolution. In the 1980s and 1990s, with the development of the Personal Computer (PC), breakthroughs in the field of Software and establishment of the World Wide Web led this sector to expand exponentially. Today, the Software industry is of major importance for the contemporary world economy, accounting for a significant proportion of the information and communication technology sector (ICT), which contributes 5.4% to global gross domestic product, according to Dutta and Mia (2010). In specific terms, 1.87 million people in the United States work in this sector, earning an average yearly salary of one hundred thousand dollars (more than twice the national average) and generating more than 412 billion dollars of gross output for the US economy.[1] In Spain, this sector provides 360 thousand employees (whose average salary is over 30 thousand euros per year) and adds 30 billion euros of gross output to the Spanish economy.[2] This industry includes Software management, programming, editing electronics, mobile Software (or apps) and the Videogames industry. We focus on the latter below.

In this paper we will focus on the Videogames industry, a specific creative industry within the Software industry that falls halfway between the Software industry and creative industries, and shares some characteristics with both (the software industry's exponential growth, technical processes and business features and the creative industries' creative components). It is important to know that the Videogames industry plays a key role in enhancing economic activity as a creative industry.

[1] OECD, STAN Dataset for Structural Analysis, ed. 2010.
[2] INE (*Instituto Nacional de Estadística*), Sector ICT indicators, ed. 2013.

The Videogames industry includes software created for entertainment purposes based on an interaction between one or more players and an electronic device that runs the game. The devices include mobile phones, Personal Computers (PC), arcade machines and Video Game Consoles, among others. Videogames are quite a recent development, as they emerged in the United States in the early 1960s with the first computer game ("Spacewars!), which was developed by Steve Russell at the MIT Lab. This game was inspired by science fiction novels and featured two spaceships shooting beams to destroy each other. Surprisingly, no attempts were made to market this videogame. The first viable business in Videogames was developed by Nolan Bushnell, the founder of Atari. He has been considered "the first of that generation of much-hyped super-successful high-tech entrepreneurs" (Aoyama & Izushi, 2003, pp. 427). Atari initially created and later fuelled the Videogames industry, initially focusing on bigger markets, such as those in Japan (with firms as Nintendo and Sega) and the United States (with Atari at the beginning and Microsoft later).

Since the 1970s, the Videogames industry has developed in tandem with the digital revolution, and the industry has experienced exponential growth. Today, the Videogames industry is important for the world economy. The industry's global spending amounted to 70.8 billion dollars in 2014, with a forecast of 89 billion dollars for 2018, or an annual mean global growth rate of 6.2%.[3] In Spain, this industry had an income of about 1078 million dollars in 2013, with a forecast of 1238 million dollars for 2017 (an annual growth rate of 3.3%).[4] As our analysis will focus on Barcelona, this sector's income in Catalonia (a region located in north-eastern Spain, whose capital is Barcelona) has more than 1,600 workers.[5] In 2015, Catalan firms developed about 150 games - 40% of which were for mobiles and 30% for online platforms.[5]

The Software and Videogames industry's location preferences are mainly inside big metropolitan areas, and specifically in the centre of them, where they can easily find skilled young professionals who are crucial to the success of these activities. There is empirical evidence for the huge importance of skilled labour for these industries and specifically, workers with outstanding capabilities in computer skills, such as computer

[3] PWC: "Global entertainment and media outlook 2014-2018"
[4] PWC España: "Global entertainment and media outlook 2013-2017"
[5] Data from the *Institut Català de les Empreses Culturals*: "Empreses de videojocs a Catalunya 2015" except the data concerning the number of employees, which is from our database.

programming and Software engineering (Autor et al., 2003). The availability of this skilled labour is a basic input for high-tech firms (which are overrepresented in large urban areas) and it even has a positive effect on urban city growth, as shown by Berger and Frey (2015).

In view of previous concerns, we aim to analyse a case study of Software and Videogames industry for a dynamic city, Barcelona, which has increasingly attracted this type of activity in recent years, due to some huge advantages, as partially illustrated by the increasing number of university degree courses available at local universities, focusing on Videogames design and on Videogames management.[6] Some key facts highlight the potentiality of this city for this industry, such as *Barcelona Games World 2016*, a worldwide event held in Madrid until 2015 which subsequently later moved to Barcelona. Although Barcelona has a long tradition of manufacturing activities, these had rapidly disappeared since the late 1970s, when most factories started to move away from the city centre, leaving enormous areas of free land available for further urban growth. Although some of these areas were transformed into residential areas, there are some interesting experiences of urban renewal projects that aimed to transform them into high-tech districts. The most famous of these is in Poblenou, a district quite close to the city centre, which in 2000 was the subject of a renewal plan by Barcelona City Council which aimed to transform this area from a mature textile manufacturing cluster into a high-tech cluster known as 22@. That experience has been a successful policy that has attracted many high-tech firms and knowledge based activities (Viladecans-Marsal and Arauzo-Carod, 2012). In spite of the success of the 22@ experience, not all new high-tech related activities have decided to locate there, as many other core areas have also attracted these new firms, as shown by data provided by the Government of Catalonia (*Institut Català de les Empreses Culturals*) for new videogames firms located in Barcelona.

Based on previous theoretical concerns, the characteristics of the Videogames and Software industries and the specificities of the Barcelona case, this paper aims to analyse the location patterns of Software and Videogames firms in the Metropolitan Area of Barcelona (hereinafter the MAB). To that end, we have used spatial oriented

[6] The Universitat de Barcelona (UB), the Universitat Politècnica de Catalunya (UPC) and Universitat Pompeu Fabra (UPF) offer Bachelor's and Master's degrees focusing on Videogames.

techniques including the Nearest Neighbour Index (NNI), M-functions and spatial autocorrelation indicators (global and local). Our preliminary results indicate that Videogames firms tend to cluster around some subcentres inside the MAB, whilst Software firms are less concentrated. The next step in our research will be to attempt to determine what explains these location patterns and therefore drives the location determinants of these firms.

The results of this paper contrast with the results on the Software industry obtained by Viladecans-Marsal and Arauzo-Carod (2012) mentioned above, which show the success of the @22 district as a knowledge-based cluster, and for which we found a slight agglomeration pattern for Videogames firms in this district.

The rest of the paper is organised as follows. Section 2 reviews the theoretical and empirical literature about firms' location determinants, focusing on the Creative industries and specifically on the Software and Videogames industries. Section 3 describes the data and methodology. Section 4 introduces some descriptive statistics and discusses results, and finally, section 5 presents the main conclusions.

2. Related literature

This paper falls between two closely linked strands of economic literature - industrial location determinants and agglomeration economies. The first, on industrial location determinants, has been a recurring topic in economics since the seminal paper by Alfred Marshall (1890) on industrial districts and the study by Edgar and Hoover (1936), among other authors. The literature exploring the location decisions of new firms has grown considerably in recent years, with wider methodologies, spatial aggregation levels and industries being analysed. That success is partially explained in terms of the potential utility of these contributions when designing public policies aiming to attract new firms.[7] The second field, agglomeration economies, shows that economic activity has a strong tendency to agglomerate, regardless of the industries, geographical areas or institutional settings concerned, although these characteristics modulate the degree of agglomeration effectively achieved. If we consider both strands together, we may

[7] An extensive review of this literature can be found in Arauzo-Carod et al. (2010).

conclude that *i)* firms (as well as many other institutions) have a clear tendency to agglomerate around other firms and *ii)* firms share specific location patterns (i.e. internal and external characteristics that guide their location decisions) with similar firms.

Nevertheless, as in this paper we are primarily interested in the spatial distribution of firms rather than in whether this distribution comes from entry decisions or from already existing firms that decide to agglomerate closer to other firms, we will concentrate our analysis on agglomeration processes, as they are hypothesised to be the main driving forces behind location patterns.

As the contributions to the literature on agglomeration economics are quite varied and address the location of economic activities in quite different ways, there have been various attempts to organise and structure them. Albert et al. (2012, p.109) consider that "this literature has been influenced by two very different traditions, economic geography and spatial statistics, and therefore has followed two different paths". The first traditions (economic geography), dealt with polygons (i.e., administrative areas) and typically used measures as the Gini or Herfindhal indices and did not take space into account in their analyses and may have consequently contained important levels bias. Later, some authors tried to overcome the previous shortcomings by controlling for space, agglomeration and concentration, for example Ellison and Glaeser (1997), Maurel and Sédillot (1999), Rosenthal and Strange (2003) and Devereux et al. (2004), among others. Later, Duranton and Overman (2005) treated space as continuous, in a strategy that overcame the previous limitations caused by MAUP, such as potential comparisons across different spatial aggregation levels. The second traditions (spatial statistics) dealt with points (i.e., firms), considering only the closest points (e.g. the Nearest Neighbour Index) or taking into account all neighbour points (e.g. K functions). K functions were initially developed by Ripley (1977) and later improved by Marcon and Puech, (2012). These measures were tested by Arbia (2001) who showed incentives to use continuous space in these types of analysis using a continuous space model.

With the introduction of these tools, numerous papers were published analysing spatial patterns in particular industries, such as food stores in Italy, analysed by Arbia et al. (2015), media industries in London by Karlsson and Picard (2011), high tech industries

in Milan by Espa et al. (2013), manufacturing firms in Paris by Guillain and le Gallo (2010), manufacturing firms in Europe as a whole by Brülhart (2001), or in a completely different area, tree location in North American forests by Li and Zhang (2007), among other authors.

By focusing on agglomeration processes in cities, an earlier work by Glaeser (1998) analysed the positive and negative effects for city firms and how local governments can solve these problems; Anderson and Bogart (2001) and Coffey and Shearmur (2002) also analysed the characteristics of employment centres in cities, and compare them with the size of their metropolitan areas and the way in which this employment was changing, and highlighted a decentralization process in employment away from the Central Business District (CBD) to another parts of the city and metropolitan area, in relative but not in absolute terms, creating a polycentric structure rather than a generalized dispersion. Berger and Frey (2015) showed the important role that the city plays in the search for skilled IT workers, and how this positively affects the location and profits of firms and there is consequently higher growth in cities where these workers are located. In the case of New York City, Currid (2006) also analyses the role of the city as a bastion of creativity, culture and artistic production, which attracts creative firms, in a process that has a positive influence on the city's growth.

Apart from the aforementioned framework for the location of economic activity and agglomeration economies, this paper specifically covers the Videogames industry, an area for which analyses are still relatively scarce, both because it is a young industry and because its borders are blurred between the Software industry and creative industries (Lorenzen and Frederiksen, 2008). It is for this reason that we present main findings related to the location determinants of all these areas: Software industries, Creative industries and the Videogames industry.

First, for location analyses of Software industries, there is extensive literature related to location determinants across countries (e.g., Parthasarathy, 2004, for India and Ó Riain, 1997, for Ireland). It is a well-established fact that firms in this industry benefit from networking and spillover effects, as well as information flows due to R&D cooperation (Cassiman and Veugelers, 2002). Additionally, the location of this type of firm is an important characteristic, since the empirical evidence shows that information plays a

significant role in generating a positive effect these firms' productivity when they are located in the same area (Arzaghi and Henderson, 2008) and that physical proximity between these firms can be essential for some exchanges of knowledge, enhancing innovation processes (Morgan, 2004).

Second, empirical analyses of the Creative industries cover a wide range of activities, ranging from manufacturing to services. As with Software industries, firms' clustering is widely acknowledged at various spatial levels, including continental level (e.g., Boix et al., 2015, for the case of Europe), national level (e.g., Cruz and Teixeira, 2014, for the case of Portugal; Lazzeretti et al., 2012, for the cases of Spain and Italy; and Fahmi et al., 2016 for the case of Indonesia), and at city level (e.g., Catungal et al., 2009, for Toronto; and Dörry et al., 2016, for Zurich). All these studies show that creative firms are highly clustered, and mostly located in metropolitan areas around medium-sized and large cities and cross-border areas with an important concentration of creative and knowledge-based activities. Generally speaking, the places that attract these activities are areas with high levels of tolerance, open-mindedness and with a large skilled population.

Third, as stated above, specific analyses for Videogames industries are quite scarce, partly because these activities have been traditionally considered together with other computer-related activities such as Software design, and also because of their newness as specific economic activities. Analyses covering Videogames industries are therefore quite varied and not easy to categorise together. For instance, while authors like Johns (2006) focus on the importance of the networks in this industry in order to demonstrate the utility of Global Production Network approaches and the uneven impact on the globalization processes, others try to explain intraurban determinants of computer games industry alongside other types of creative firms (e.g., Murphy et al., 2015, for the case of Dublin) or adopt a broader geographical approach in which clusters of different sizes are considered (e.g., Tschang and Vang, 2008, for the U.S.; Darchen, 2015, for Australia, and Santos et al., 2016, for Portugal).

3. Data and methodology

3.1 Data

The data used in this paper comes from the *Àrea de Cultura Digital* (*Institut Català de les Empreses Culturals*) and SABI (*Sistema de Análisis de Balances Ibéricos*). The former one is a Government of Catalonia public institution responsible for digital media activities including Videogames, books and music, and the latter compiles data on firms using the Register of Companies. The data obtained for Software, Videogames and editing electronics firms is from the SABI Database[8], while the Videogames firms data were obtained from the *Àrea de Cultura Digital*, which provides an extensive list of Videogames firms obtained from the institution's day-to-day interaction with firms working in this industry. We have matched the two sources, as the SABI data was used to complete the database from the *Àrea de Cultura Digital* (i.e. number of employees, sales and assets, among other characteristics) and we contacted firms directly if the firms listed in the *Àrea de Cultura Digital* were not compiled by the SABI. Our final dataset contains 104 Videogames firms located in Catalonia (25.15% of the Spanish total in 2015)[9], although some of them (17) do not have enough data to be georeferenced.[10]

As mentioned in the introduction, we focus on the Metropolitan Area of Barcelona (hereinafter the MAB), located in Catalonia, north-eastern Spain. The MAB (see Figure 1) covers an area of 636 km^2, has around 3.2 million inhabitants and includes 36 municipalities.[11]

[8] The SABI database contains a long list of variables, including year of constitution, balance sheets, income, expenditure accounts, number of employees, industry, sales, assets, and georeferenced location (i.e., X-Y coordinates). The data is collected by SABI from the Register of Companies, where all limited liability companies and corporations are obliged by law to deposit their balance sheets. Due to its coverage SABI is the most widely used database in Spain when firm georeferenciation is required.

[9] Data provided by the Government of Catalonia.

[10] Concretely, 2 Videogames firms do not report any headquarter and 15 have missing locational data.

[11] The municipalities in the BMA are Barcelona, l'Hospitalet de Llobregat, Badalona, Santa Coloma de Gramenet, Cornellà de Llobregat, Sant Cugat del Vallès, Sant Boi de Llobregat, Viladecans, el Prat de Llobregat, Castelldefels, Cerdanyola del Vallès, Esplugues de Llobregat, Gavà, Sant Feliu de Llobregat, Ripollet, Montcada i Reixac, Sant Adrià de Besòs, Sant Joan Despí, Barberà del Vallès, Sant Vicenç dels Horts, Sant Andreu de la Barca, Molins de Rei, Sant Just Desvern, Corbera de Llobregat, Badia del Vallès, Castellbisbal, Pallejà, Montgat, Cervelló, Tiana, Santa Coloma de Cervelló, Begues, Torrelles de Llobregat, el Papiol, Sant Climent de Llobregat, and la Palma de Cervelló. See http://www.amb.cat/ for further details.

Figure 1: Metropolitan Area of Barcelona (MAB)

Source: http://www.amb.cat/

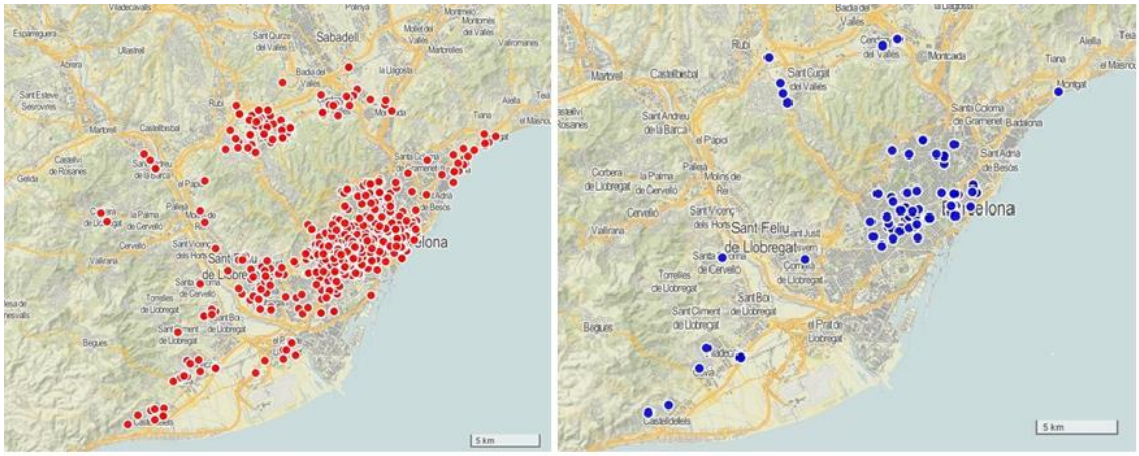
The main reason to focus on the MAB is the large number of firms located in and around Barcelona. In specific terms, 74 of the 104 Catalan Videogames firms are located in the MAB (54 of them in the city of Barcelona), which accounts for around 71% of firms in the industry. The MAB also attracts a large number of software, videogames and editing electronics firms (hereafter SVE): 858 SVE firms including Videogames firms (see figures 2 and 3).[12]

Although Barcelona is clearly the economic and institutional hub of the MAB, there are also some spatial inequalities inside the city which need to be controlled. For this reason, we will also divide the city into 10 districts and 73 neighbourhoods (i.e. we will use the districts/neighbourhoods map designed by the City Council). Additionally, using

[12] There is an empty area in the north-northwest of the BMA which is a wooded mountain area (Collserola) between Barcelona and the northwestern municipalities.

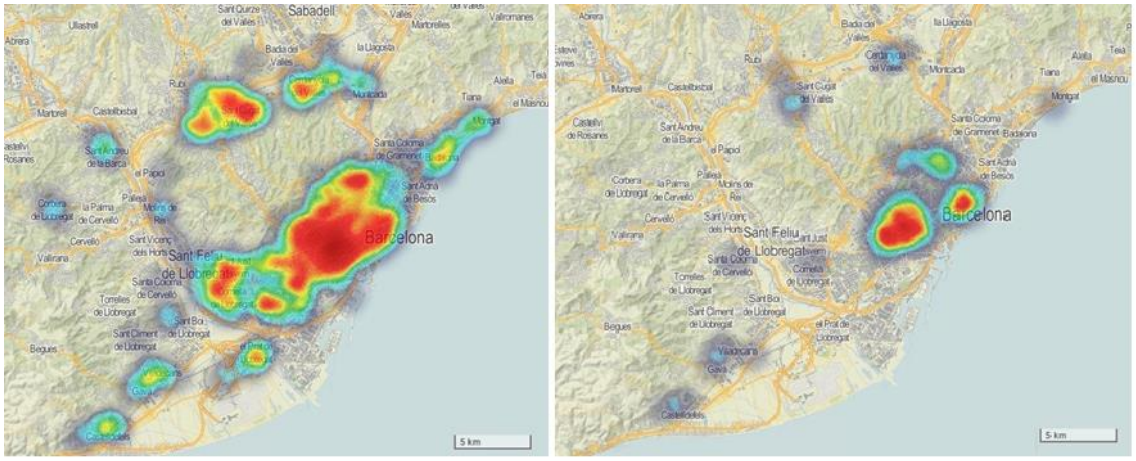
districts will allow us to compare them to municipalities in the MAB other than Barcelona, as they are of a similar size. If we focus on the 10 districts, it is apparent that economic residential and activities are unequally distributed across the districts. Peripheral low/medium-income districts such as Poblenou, Horta-Guinardó, Sant Andreu and Sant Martí mainly host residents, Sants-Montjuïc is a traditional manufacturing area which has today been reoriented towards residential uses and tourism, traditional core areas such as Ciutat Vella are tourism-oriented, the CDB (Eixample district) includes a mixture of tourism, residential and service-oriented activities, Sarrià-Sant Gervasi and Gràcia are medium/high-income districts that also include some service-oriented activities and finally, Les Corts is a medium/high-income district where most of the universities are located.

Figure 2: SVE and Videogames industry firms in the MAB. 2015.



Source: SABI, *Institut Català de les Empreses Culturals* and own research. The red and blue dots are SVE and Videogames firms, respectively.

Figure 3: Heat map from the SVE and Videogames industry in the MAB. 2015.



Source: SABI, *Institut Català de les Empreses Culturals* and own research. The map on the left hand side refers to SVE firms, while the map on the right hand side refers to Videogames firms.

In order to identify industries for consideration in this analysis, we used the classification by Boix and Lazzeretti (2012) which summarises several classifications of creative industries by cultural agencies and international expert groups (e.g. the OECD, the WIPO and the UNCTAD). According to this classification, we obtain 17 categories related to the creative industries (see Table 1).

Table 1: Firms of Creative industries in the MAB. Year 2015.

Industry	Acronym	N	Share
Advertising and related services	ADV	1,218	15.59
Architecture and engineering	AE	1,587	20.31
Art and antiques trade	ART	47	0.60
Crafts	CR	49	0.63
Publishing	ED	538	6.89
Fashion	FA	380	4.86
Graphic arts	GA	927	11.87
Heritage, cultural sites and recreational services	HE	691	8.85
Creative research and development	IDC	148	1.89
Jewellery, musical instruments, toys and games	JEW	105	1.34
Music and music studies	MU	74	0.95
Performing Arts	PA	264	3.38
Photography	PHO	161	2.06
Radio and TV	RTV	66	0.84
Software, videogames and editing electronics	SVE	858*	10.98
Specialised services design	SSD	272	3.48
Video and film industries	VFI	427	5.47
Total number of firms		**7,812**	**100.00**

* 4 firms from SVE were not georeferenced.
Source: SABI.

Table 1 shows that the most important creative industries in the MAB include Architecture and engineering, Advertising and related services, Graphic arts and Software, videogames and editing electronics. This dataset only includes firms located in the MAB with available information on the address of the headquarters, data about the number of employees and operating in 2015.[13] Table 2 summarizes the firm data used in this paper[14] and tables A1 and A2 (see the appendix) show the number of SVE firms since the 1990s nineties in both Barcelona and the MAB.

[13] Initially, we compiled 19,229 firms from the province of Barcelona (NUTS 3 level) from the SABI. After some filtering, we discarded 11,491 firms with missing data or which were not located in the BMA, and to this dataset (7,738) we added 74 Videogames firms in order to obtain a final dataset of 7,812 firms.
[14] The firm level data includes location, age and number of employees.

Table 2: Number of firms summary

	Videogames firms (104)		SVE firms (858)	
	With all data	**With missing data**	**With all data**	**With missing data**
Catalonia	87	17	1984	0
MAB	70	4	854	4
Barcelona	54	0	640	0

Source: Compiled by the authors.

3.2 Methodology

In order to analyse the location patterns of SVE ini the MAB, we used several techniques including Spatial Autocorrelation analysis, Nearest Neighbour Index (NNI) and M-functions. All these techniques can be used together in order to identify firms' location patterns, because they do not measure exactly the same dimensions. While Spatial Autocorrelation analysis focuses on spatial autocorrelation through geographical units (e.g. neighbourhoods, municipalities and regions) and shows results for these geographical units, NNI analyses the spatial concentration of points (e.g., firms) in a territory, and does not taking into account whether firms are in different geographical units, and M-functions analyses concentration (from the same industry) and agglomeration (between two industries) of firms by considering their number of employees. When used together, these techniques provide us with an overall spatial approach for different industries at several levels.

Spatial autocorrelation (Moran's I and LISA)

Figure 2 suggests that SVE firms are clustered in some areas of the MAB and specifically, in Barcelona, but we needed to check if this pattern really existed by using Moran's I and the Local Index of Spatial Association (hereinafter LISA).

Before calculating spatial autocorrelation, it is necessary to define a spatial-neighbour matrix (W) in order to identify neighbourhood patterns among spatial units. Ee will use the 73 neighbourhoods defined by Barcelona's city council and we will consider that two neighbourhoods are neighbours if they share a common border.[15]

[15] There are several alternative definitions for neighbours (k-nearest neighbours, contiguous neighbours, or distance-based neighbours, among others) but considering that this is an intraurban analysis in which neighbourhoods are quite close to each other in a defined space (Barcelona) we considered that the most appropriate measure is contiguity.

Once W has been identified, we calculate two measures of spatial autocorrelation: Moran's I (Moran, 1948) and LISA (Anselin, 1995). The values of Moran's I indicate a negative spatial autocorrelation if they range from -1 to 0; a positive spatial autocorrelation if they range between 0 and 1; and a random distribution if they are around 0. LISA identifies whether spatial autocorrelation is geographically constrained to certain areas (i.e. neighbourhoods).

Nearest Neighbour Index (NNI)

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

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

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 region considered. The values of NNI are interpreted as follows: values around 0 indicate a clustered pattern, values around 1 indicate a random distribution of the points, and values higher than 2 indicate an uniform pattern. NNI has been used previously (Rehák and Chovanec, 2012) to analyze the location patterns of creative industries in Slovakia.

M-functions

M-functions (Marcon and Puech, 2010) enable the capture of spatial clustering and are of increasing interest to researchers, although some previous related measures are worthy of attention, such as Ripley's K. This function was developed by Ripley (1976) and computes the density of any set of points (i.e., firms) for a given radius of distance

in order to control if there is clustering at certain distances. Distance radii are therefore calculated around every point, and K(d) is the mean density of points for every distance radius (d) and this density is divided by the mean density of points (n) in the area as a whole (a): n/a. At first glance, the interpretation of Ripley's K seems to be quite similar to that of NNI, when the expected random values are compared with observed values. If the observed values exceed the expected values, there is a clustered pattern; and if the observed values are lower than the expected values, there is a dispersed pattern.

Later, M-functions were introduced by Marcon and Puech (2010) as a cumulative function. These functions can evaluate the geographic intra-industry location (concentration) of a given industry or the co-location (agglomeration) between two industries, using the number of employees as a weight measure. A more in-depth explanation of these functions can be found in the Appendix.

Numerous papers use the M-functions as a tool to explain concentration, agglomeration and dispersion patterns between industries such as the study by Moreno-Monroy and Cruz (2015), who use this distance-based method to measure the agglomeration patterns of formal and informal manufacturing activity within the metropolitan area of Cali. Likewise, Coll-Martínez et al. (2016) analyse spatial patterns of agglomeration of creative industries in the Metropolitan Area of Barcelona using *M* and *m* functions.

The values of these functions are represented in a plot graph, indicating an M-value for each distance: if the M-value is outside the confidence interval at the top of the plot, then there is concentration (intra-industry) or agglomeration (inter-industry), and if the M-value is outside the confidence interval at the bottom of the plot, then there is dispersion of the industry (intra-industry) or between industries (inter-industry). If M-values are inside the confidence interval then the results are not conclusive.

4. Results

4.1 Some descriptive statistics

Table 3 presents some descriptive statistics for firms belonging to the SVE (858 firms), Videogames industry (74) and creative industries (7,812) located in the MAB[16]. It shows that firms in the Videogames industry are younger (5.7 years old on average) than SVE firms (13.0) and the creative industries as a whole (16.0), and they are also larger (21.3 workers on average) than their counterparts in the SVE (19.1) and creative industries (10.8).

Table 3: Statistical descriptive information. Year 2015

	Mean	Standard Deviation	Min	Max	Median
Videogames Industry					
Workers	21.3	59.5	1	400	5
Age	5.7	4.8	0	22	4
Number of firms	74				
SVE Industry					
Workers	19.1	75.5	1	1,329	4
Age	13.0	7.6	0	62	12
Number of firms	858				
Creative Industries					
Workers	10.8	58.9	1	2,480	2
Age	16.0	9.6	0	144	14
Number of firms	7,812				

Source: SABI, *Institut Català de les Empreses Culturals* and own research.

4.2 Agglomeration of Software & Videogames industry

We will begin the analysis by focusing on whether software and videogames firms tend to locate together (NNI) in a small number of locations or on the contrary, tend to disperse. We will then analyse whether previous patterns may be part of a spatial dependence process, and we will check this using global (Moran's I) and local (LISA) measures. Finally, we will use a distance-based method of spatial concentration (M-function) to quantify previous concentration patterns and identify their spatial scope, and to check whether there is any evidence on co-location between pairs of industries.

[16] These firms (Videogames and SVE Firms) are obtained from the firm's data with the age and number of workers available (firms with missing values were not included in the analysis).

The results in Table 4 indicate that there is some evidence of clustering for both Videogames firms (NNI value of 0.47660) and all SVE firms (0.33428) in the MAB, but the phenomenon is stronger in the latter case. Nevertheless, as we are particularly interested in Videogames firms, we want to analyse whether this clustering is related to firm's specific characteristics, and as such we have grouped Videogames firms on the basis of age (new firms vs. old ones) and size (young firms vs. big ones)[17]. Our results show that clustering mainly takes place among young (NNI value of 0.47140 vs. 0.63081) and small (0.54472 vs. 0.84070) firms.

Table 4: Nearest Neighbour Index from SVE & Videogames Industry in the MAB

			Videogames firms Age		Videogames firms Size	
	All SVE firms	**Videogames firms**	**Old firms (> 6 years)**	**New firms (≤ 5 years)**	**Big firms (> 3 workers)**	**Small firms (≤ 3 workers)**
Average observed distance*	184.558	811.614	1452.011	996.173	2135.768	1117.359
Average expected distance*	551.453	1703.278	2302.538	2113.531	2528.233	2052.383
Nearest neighbour index	0.33428	0.47660	0.63081	0.47140	0.84070	0.54472
Number of observations	854	70	34	36	25	45
Z-Value	-37.21748*	-8.37739*	-4.11767*	-6.06745*	-1.52290**	-5.84268*

Significance levels: (*): p<0.01 (**): p<0.1. *The distances are in metres.
Source: Own research

According to these results, clustering appears to be a competitive strategy for younger and smaller firms that need spatial proximity with similar firms in the same industry in order to benefit from positive agglomeration externalities. For instance, this implies a stronger propensity to locate in business incubators or in/around technological research centres. Similarly, it is also reasonable to assume that older and bigger firms may have internalised some of these external resources, and are less dependent on these agglomeration externalities. This is a well-established effect, which is also known as liability of newness and liability of smallness (Agarwal et al., 2002). These results are

[17] The cut-off point of firms' ages was obtained by the median, whereas for size we considered that firms with more than 3 employees were not small firms by this industry's standards (the median size is 5 employees).

consistent with those of Slach et al. (2015), as they show a similar degree of clustering for this type of industry, and the results of Rehák and Chovanec (2012) who show that these industries tend to be clustered in big cities, as we show here.

Table 5: Districts, Neighbourhoods and number of firms by Neighbourhood

District	NBH	SVE	VDG	District	NBH	SVE	VDG
Ciutat Vella	**1**	4	1	Horta-Guinardó	**38**	1	0
	2	8	0	(cont.)	**39**	0	0
	3	0	0		**40**	1	0
	4	6	0		**41**	7	1
Eixample	**5**	8	0		**42**	0	0
	6	12	0		**43**	3	1
	7	107	8	Nou Barris	**44**	2	1
	8	52	4		**45**	3	0
	9	32	3		**46**	1	0
	10	13	0		**47**	0	0
Sants-Montjuïc	**11**	1	0		**48**	7	2
	12	3	0		**49**	0	0
	13	2	0		**50**	0	0
	14	2	0		**51**	0	0
	15	2	0		**52**	2	0
	16	2	0		**53**	0	0
	17	4	0		**54**	0	0
	18	6	1		**55**	0	0
Les Corts	**19**	43	4		**56**	0	0
	20	7	0	Sant Andreu	**57**	0	0
	21	10	0		**58**	0	0
Sarrià-Sant Gervasi	**22**	0	0		**59**	1	0
	23	10	0		**60**	3	1
	24	6	0		**61**	10	3
	25	11	1		**62**	2	1
	26	62	4		**63**	2	0
	27	9	1	Sant Martí	**64**	6	1
Gràcia	**28**	7	0		**65**	4	0
	29	1	0		**66**	37	4
	30	6	0		**67**	10	1
	31	25	2		**68**	15	1
	32	10	1		**69**	16	2
Horta-Guinardó	**33**	12	0		**70**	1	0
	34	1	0		**71**	15	5
	35	2	0		**72**	3	0
	36	2	0		**73**	0	0
	37	0	0	TOTAL		640	54

Note: "NBH" indicates neighbourhoods (a list of neighbourhood names can be found in Table A3, in the Appendix), "SVE" is the number of SVE firms and "VDG" is the number of Videogames firms.
Source: Own research.

Having identified that firms tend to locate closer to each other than would be expected in a random pattern, we need to identify whether this is due to a spatial dependence

process. Our empirical strategy will start at regional level, taking into account municipalities in the MAB and districts (10) in Barcelona, as *i)* according to their size they are reasonably comparable to all the municipalities in the MAB apart from Barcelona, and *ii)* using the entire city of Barcelona as a spatial aggregation area may lead to bias in the results, as this city is much larger than the other municipalities in the MAB. As most SVE and Videogames firms are located in Barcelona, we will then focus on this city at neighbourhood level (73). There are 640 SVE firms (including 54 Videogames firms) located in the city of Barcelona, as shown in Table 5. Most are located in the districts of Eixample (35.0% of SVE firms and 27.8% of Videogames firms), Sant Martí (16.7% and 25.9% respectively) and Sarrià-Sant Gervasi (15.3% and 11.1% respectively).

The values for Moran's I indicate that there is positive spatial autocorrelation for SVE firms, in both the MAB as a whole (0.3484) and in the city of Barcelona (0.3617). For Videogames firms, although there is still a positive autocorrelation for both areas, the values are lower (0.2886 for the MAB and 0.1680 for Barcelona) and close to a random pattern for the case of Barcelona. Taking both areas and industries into account, our results show that there are various agglomeration mechanisms that may be caused by specificities of these industries and geographical areas. Even if it seems reasonable to anticipate higher levels of spatial autocorrelation in a more homogeneous area like the city of Barcelona, the results for Videogames firms may be explained in terms of the large number of firms located in Sant Cugat del Vallès, a high-income city located close to Barcelona that is home to an important number of high-tech activities, including firms, research centres and research parks.[18]

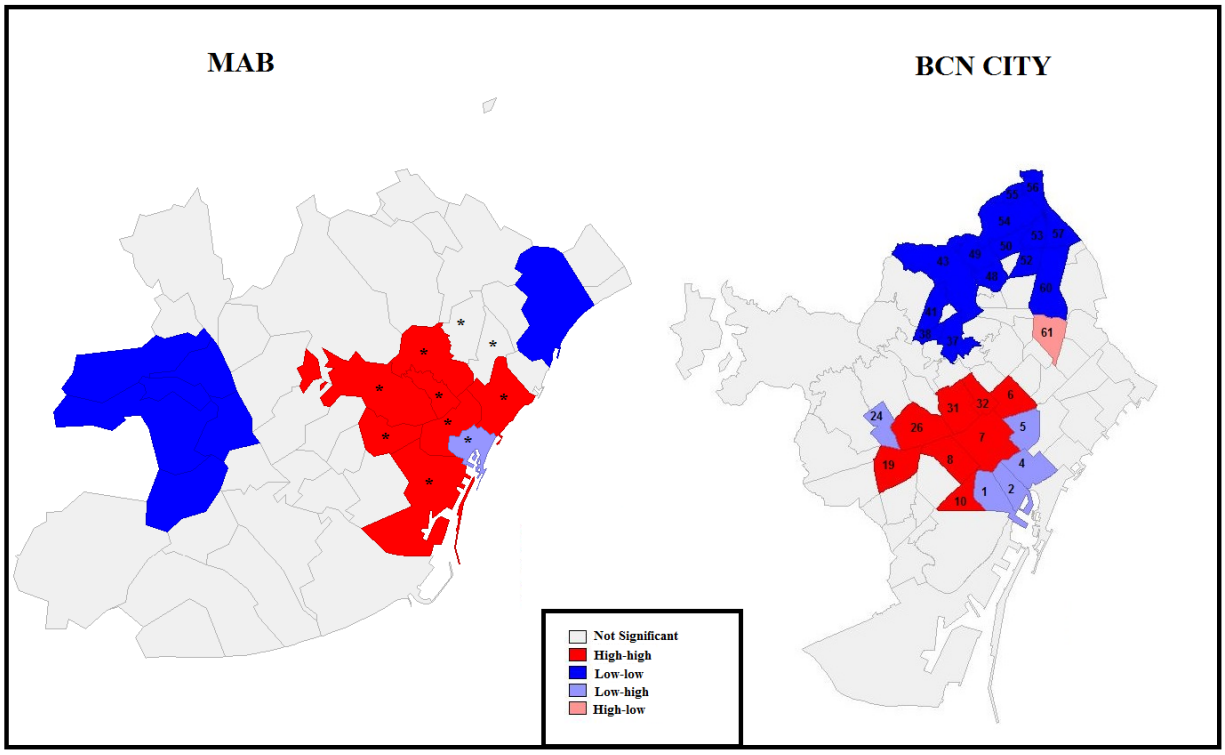
Whilst Moran's I provides an overview of the spatial autocorrelation of location patterns of firms, LISA allows a more in-depth examination of the geographical specificities of this phenomenon[19]. Figure 4 shows the LISA results for SVE firms for both the MAB (left-hand side) and the city of Barcelona (right-hand side). The results for the MAB clearly show that there is a high-high spatial autocorrelation at the core of

[18] This effect on the level of the BMA is due to the large number of firms located in Barcelona and to the proximity of Sant Cugat del Vallès to Barcelona, which are the second- and first-ranked municipalities in terms of the number of videogames firms (the two municipalities have more than 80% of the Videogames firms situated in the BMA), producing this Moran's I value, which is higher than the level for the city of Barcelona.

[19] The calculations were made using a 0.05 significance level and 499 permutations.

the area (i.e., areas hosting a large number of firms are neighbours) that is mostly in the city of Barcelona (i.e. including 7 of its 10 districts), whilst there is a low-low spatial autocorrelation area (i.e. areas hosting a small number of firms are neighbours) in the western municipalities of the MAB, which are mainly residential. After noting this phenomenon in Barcelona, the next stage is to analyse the LISA results for the city in order to identify the areas (i.e. neighbourhoods) where this high-high spatial autocorrelation exists more precisely. The right-hand side of Figure 6 shows that spatial dependence of neighbourhoods with a large number of firms (i.e. red areas) is mainly on both sides of the Avinguda Diagonal, Barcelona's main traffic route, in areas in/around the CBD and where most of the university faculties are located, whilst the opposite (i.e. blue areas) are mainly found in low-income neighbourhoods in the east of the city where the land use is mainly residential rather than economic. Our results show that there is no agglomeration in the Poblenou neighbourhood (see the right-hand map in Figure 4) and the surrounding areas (i.e. in the 22@ project, a public initiative that aims to transform this area into a huge high-tech hub), which shows that SVE firms prefer other central areas in the city (see Viladecans-Marsal and Arauzo-Carod, 2012).

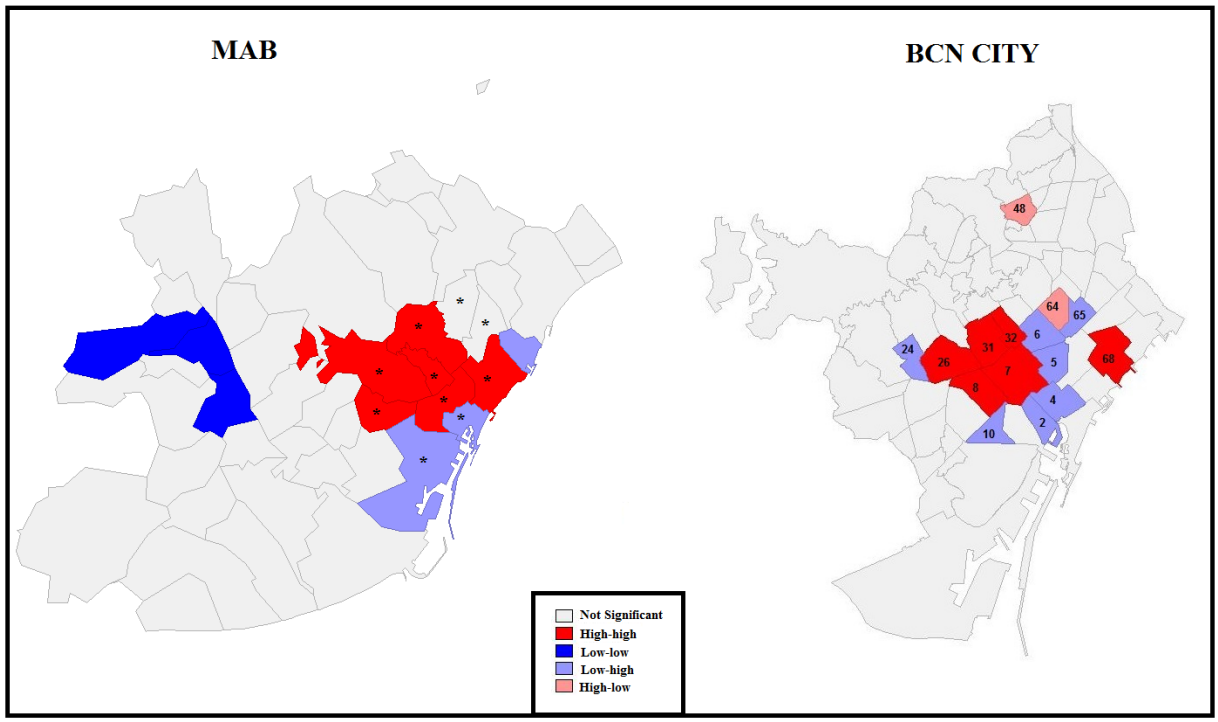
Figure 4: LISA for the MAB and the city of Barcelona (SVE firms)



N.B.: The numbers denote the neighbourhoods' codes.
Source: Own research. (*) Barcelona city sistricts.

Figure 5 shows the same analysis for Videogames firms and unsurprisingly provides similar results, as at the MAB level there is an area of high-high spatial autocorrelation (i.e. red areas) for most of the districts of Barcelona (6 out of 10) and a low-low area (i.e. blue areas) in the western residential municipalities of the MAB. For the city of Barcelona, the results for Videogames firms show a similar high-high pattern in the CBD neighbourhoods on both sides of the central section of the Avinguda Diagonal and in the Poblenou neighbourhood, an area that has received special attention from Barcelona City Council thanks to the 22@ project (see Viladecans-Marsal and Arauzo-Carod, 2012).

Figure 5: LISA for the MAB and the city of Barcelona (Videogames firms)



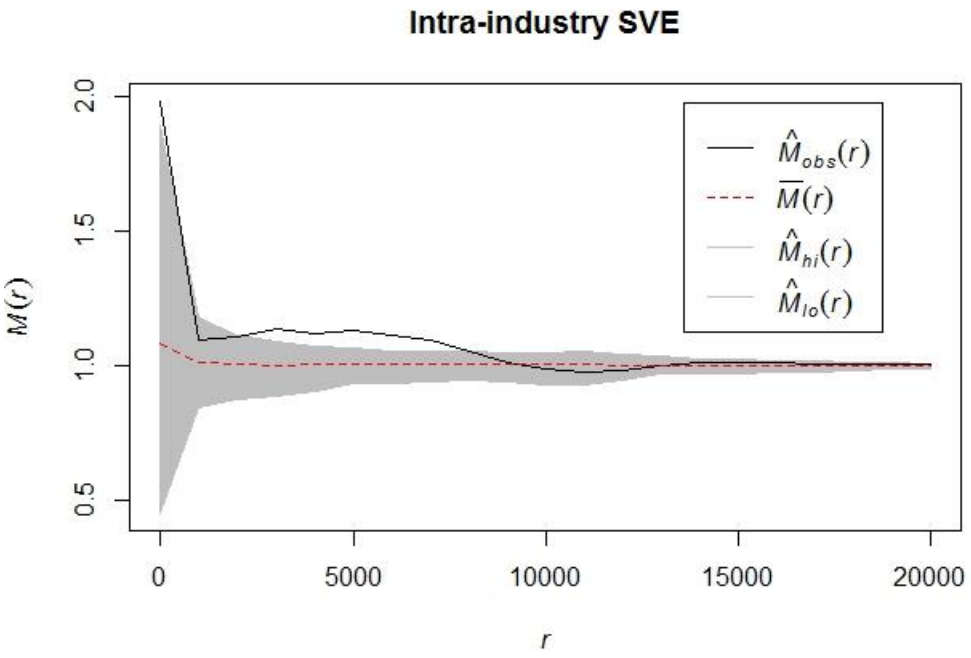
Note: Numbers refer to the neighbourhoods' codes.
Source: Compiled by the authors. (*) Barcelona city Districts.

At this stage, when concentrations of SVE and Videogames firms have been identified for both the MAB and Barcelona, the next step is to use M-functions to quantify the spatial scope of these location patterns (i.e. the intra-industry level) and to check if there is any evidence for co-location between pairs of industries (i.e. the inter-industry level). We will analyse the inter-industry location linkages of SVE and Videogames firms with some other creative industries (Advertising and related services, Publishing, Graphic Arts, Software, Videogames and editing electronics, and Video and Film industries) that

we suspect tend to collocate with them. First of all, we analyse the intra-industry effects and then the inter-industry effects.[20]

Figures 6 and 7 respectively show the M-functions at the intra-industry level for the SVE industry and Videogames industry. The results for SVE suggest a high concentration of firms from that industry (at the peak the concentration is almost twice that observed in the area as a whole) in a radius of around 7.5 km. This result means that when comparing relative density of employees of the SVE industry around each firm belonging to that industry, the density is higher than the density observed for the area as a whole (the MAB). The data shown in Figure 6 corroborate the previous results from the NNI and spatial autocorrelation tools, but M-functions enable this clustering pattern to be quantified by determining the mean peaks around firms for the industry (i.e. twice the mean density) and the spatial range of this phenomenon (i.e. up to 7.7 km).

Figure 6: Intra-Industry concentration of the SVE industry in the MAB

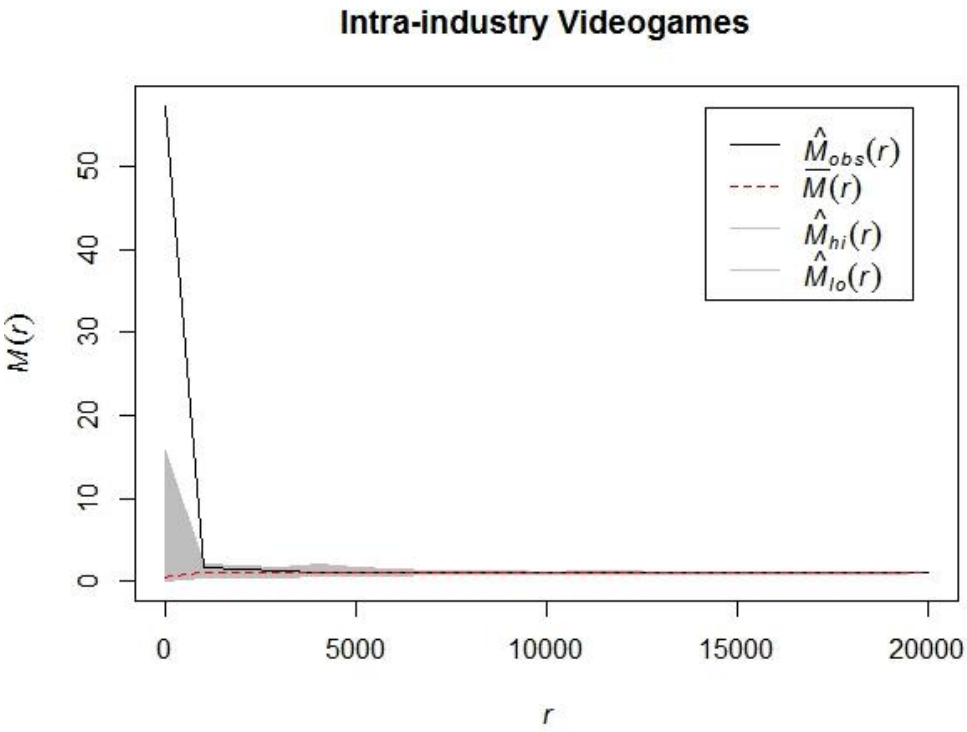


Horizontal axis units (*r*): meters.
Source: Compiled by the authors.

[20] All calculations were made at a 0.05 significance level, using 150 simulations.

The Videogames industry (Figure 7) has a remarkable concentration that peaks at about 60 times the expected density of employees for close distances, then declines rapidly and within a radius of roughly 1 km. In this case, our results indicate that intra-industry linkages occur at very short distances, as firms in the Videogames industry have similar needs in terms of their location determinants. Nevertheless, it is important to note that this result does not imply that all firms from this industry are located in the same place or only at very short distances from each other. It means that firms cluster, although they may cluster in different places.

Figure 7: Intra-Industry Concentration of Videogames industry in the MAB



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

In terms of inter-industry effects, Table 6 summarises the inter-industry relations of SVE and Videogames respectively, with some pairs of industries (all Creative industries, Advertising and related services, Publishing, Graphic arts, and Video and film industries). In general terms, most of these pairs have no significant agglomeration (or dispersion) effects (especially for Videogames), which suggests that these firms do not tend to agglomerate around the selected creative industries and vice-versa.

Table 6: Inter-Industry effects summary

Categories	SVE Firms	Videogames Firms
All Creative	Dispersion	Dispersion
Advertising and related services	Agglomeration	*Not significant*
Publishing	*Not significant*	*Not significant*
Graphic arts	Dispersion	*Not significant*
Video and film industries	Agglomeration	Agglomeration
SVE	-	*Not significant*
Videogames	*Not significant*	-

Source: Compiled by the authors.

Nevertheless, there are some exceptions in which agglomeration/dispersion effects are present[21]. For SVE, there are mild agglomeration effects with Advertising and related services and Video and film industries (see Figures A8 and A9). The relative density of employees in Advertising and related services firms located around SVE firms is higher (around a radius of 6 km) than that observed for the whole area, whilst there is a similar result for SVE firms around Advertising and related services firms but between an approximate radius of 2 and 7 km. The same pattern is observed for Video and film industries firms locating around SVE firms (see Figures A20 and A21) but at a radius of 9-10 km, and for SVE firms locating around Video and film industries firms the agglomeration is identified as a radius of between 2 and 7 km. There is also empirical evidence of dispersion effects. When the location patterns of SVE firms and all creative industries firms are analysed together, there is consistent empirical evidence of a dispersion effect of all creative industries firms around SVE firms, as the relative density of employees in all creative industries firms is smaller in a 9 km radius than that observed for the whole area (see Figure A4), whilst the opposite is also true (i.e. dispersion of SVE firms around all creative industries firms) but only in a radius of roughly 1 km (see Figure A5). There are also dispersion effects when the location patterns of SVE firms and Graphic arts are compared. These effects are especially important for Graphic arts firms located around SVE firms (see Figure A16), as the relative densities of employees are lower than for the whole area in a radius of 20 km, whilst when SVE firms around Graphic arts firms are analysed (see Figure A17), the radius for which dispersion effects are reported is about 6 km.

For Videogames firms, there is significant evidence for the Video and film industries (agglomeration) and for all creative industries (dispersion). Agglomeration effects are

[21] The M-function graphs (from A4 to A25) summarised in Table 6 are provided in the Appendix.

found mainly for firms in the Video and film industries around Videogames firms (see Figure A22), with a peak relative density of employees 50% that is higher than for the area as a whole at a radius of 2 km. There are dispersion effects between all creative firms and Videogames in both directions over very short distances (see Figures A6 and A7).

5. Conclusions

This paper is consistent with the main tenets of recent empirical literature analysing location patterns of specific industries at very detailed geographical levels, and shows that SVE and Videogames industries follow similar patterns to other service industries by tending to cluster around some central areas of the Metropolitan Area of Barcelona (MAB) as a whole, and Barcelona city centre in particular. We have focused these industries in view of their strategic relevance for more developed economies, and also because they tend to cluster in and around large urban areas (i.e. the MAB hosts around 67% of Videogames firms operating in Catalonia), attracted by their environment with creative know-how, a skilled workforce, educational institutions providing specialised training programs and internationally renowned professional events such as *Barcelona Games World 2016*. However, very little is known about their specific location patterns and in particular, whether they tend to co-locate close to other creative industries.

Our results show that firms' characteristics partially help to explain their location preferences, as smaller/younger firms behave in a different way to larger/older firms. We also tested whether the location of firms for these industries is spatially autocorrelated, using both global (Moran's I) and local measures (LISA). Moran's I indicates a moderate spatial correlation for SVE industries at the level of the MAB and the city of Barcelona, whilst for the Videogames industry evidence it is even smaller in both cases, and there is almost no difference between the MAB and the city of Barcelona. Nevertheless, local measures are of great interest as they highlight some similarities and differences for both industries. First, the majormain similarities arise from high-high levels of association in the central neighbourhoods (mainly around

Barcelona's main traffic route, Avinguda Diagonal) and in the 22@ neighbourhood, an area where Barcelona City Council has promoted a cluster of high-tech firms. Second, the main differences are in terms of low-low association areas, because whereas for the SVE industry there is a big area in low-income districts located north-east of the city, there is no similar phenomenon for Videogames, for which there is no significant low-low area.

The M-function results validate previous conclusions from spatial autocorrelation measures and suggest further insights for both industries. In specific terms, they contextualize the SVE and Videogames industries in terms of creative industries' location patterns. Surprisingly, the two industries are not clustered around the whole range of creative industries, which is a result that suggests some degree of heterogeneity of locational preferences in high-tech creative activities of this type. A more in-depth examination of the classification of creative industries shows that the patterns differ between the SVE and Videogames industries. Namely, whilst for the former there is a significant clustering pattern with Advertising and related services and Video and film industries, and a dispersion pattern with Graphic arts and all creative industries; for the latter there is neither a clustering or dispersion pattern (except for some agglomeration with the Video and film industries, and some dispersion with all creative industries). These results indicate that inter-industry interactions of the SVE and Videogames industries are quite specific, and exist only for some creative activities.

Our results have important implications for policies aiming to attract and encourage the local development of firms in the SVE and Videogames industries, as they provide some key facts about the locational preferences of firms in these industries. Although both industries are concentrated in and around the MAB, the concentration of Videogames industry is noticeable in the city centre of Barcelona and particularly around two subcentres located *i)* on both sides of the Avinguda Diagonal and *ii)* in the 22@ district. It is important that policymakers take these firms' preferences into account in order to provide some specific services that could make Barcelona an even more appealing destination for them. As the Videogames industry is rapidly growing worldwide, the challenge for local policymakers is to continue attracting new firms and related activities that could enhance the competitiveness of Barcelona's cluster.

this analysis obviously suffers from some limitations that need to be resolved in future research. Firstly, as we have focused on the official definition of the MAB we only considered 36 municipalities, but there are alternative classifications of the same area from a functional point of view, which include a larger number of municipalities in this metropolitan area (e.g. 165 municipalities according to Spanish Ministry of Public Works)[22]. Second, as these are very dynamic industries it is not at all clear whether the entire universe of firms has been captured in our datasets. We will leave the analysis of whether our conclusions hold for alternative definitions of the MAB and alternative data sources about firms in those industries for further research.

[22] For further details, see "Las Grandes Áreas Urbanas y sus municipios 2015" at http://www.fomento.gob.es/NR/rdonlyres/416CE7FD-A6B0-431D-881B-D1F07664795E/133984/listado__2015_2.pdf.

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APPENDIX

M-functions:

For the intra-industry location analysis, we define the expression for a particular industry *S* as:

$$M_S(r) = \sum_{i=1}^{N_S} \frac{\sum_{i=1, i \neq j}^{N_S} c_S(i,j,r) x_j}{\sum_{j=1, i \neq j}^{N} c(i,j,r) x_j} / \sum_{i=1}^{N_S} \frac{X_S - x_i}{X - x_i}$$

, where N_S is the total number of firms in the industry *S*, the numerator calculates the relative weight of industry *S* by comparing it with all the activity inside circles of radius *r*, as $c_S(i,j,r)$ is a dummy variable that takes the value 1 whether the distance between *i* and *j* firms in industry *S* is less than the radius *r*. For all activities, we define a dummy $c(i,j,r)$ as equal to 1 if firm *j* (in any industry) is located at a distance less than or equal to *r* from firm *j*. The denominator is the relative size of the industry *S* compared to all activities, X_S is the number of employees of the industry *S*, *X* is the same but for all industries, x_i and x_j are the number of employees for the firm *i* and *j*. M values higher than 1 ($M_S(r)>1$) therefore indicate that there are more employees of firms in industry *S* in a radius of *r* than in the area as whole, values equal to 1 indicate the same location pattern for the industry *S* in the whole area, and values lower than 1 ($M_S(r)<1$) show dispersion, indicating fewer employees of industry *S* in a radius of *r* around the establishments than in the area as a whole.

For the inter-industry analysis (co-location) we use the following expressions:

$$M_{S_1,S_2}(r) = \sum_{i=1}^{N_{S_1}} \frac{\sum_{i=1}^{N_{S_2}} c_{S_2}(i,j,r) x_j}{\sum_{n=1, i \neq n}^{N} c(i,j,r) x_n} / \sum_{i=1}^{N_{S_1}} \frac{X_{S_2}}{X - x_i}$$

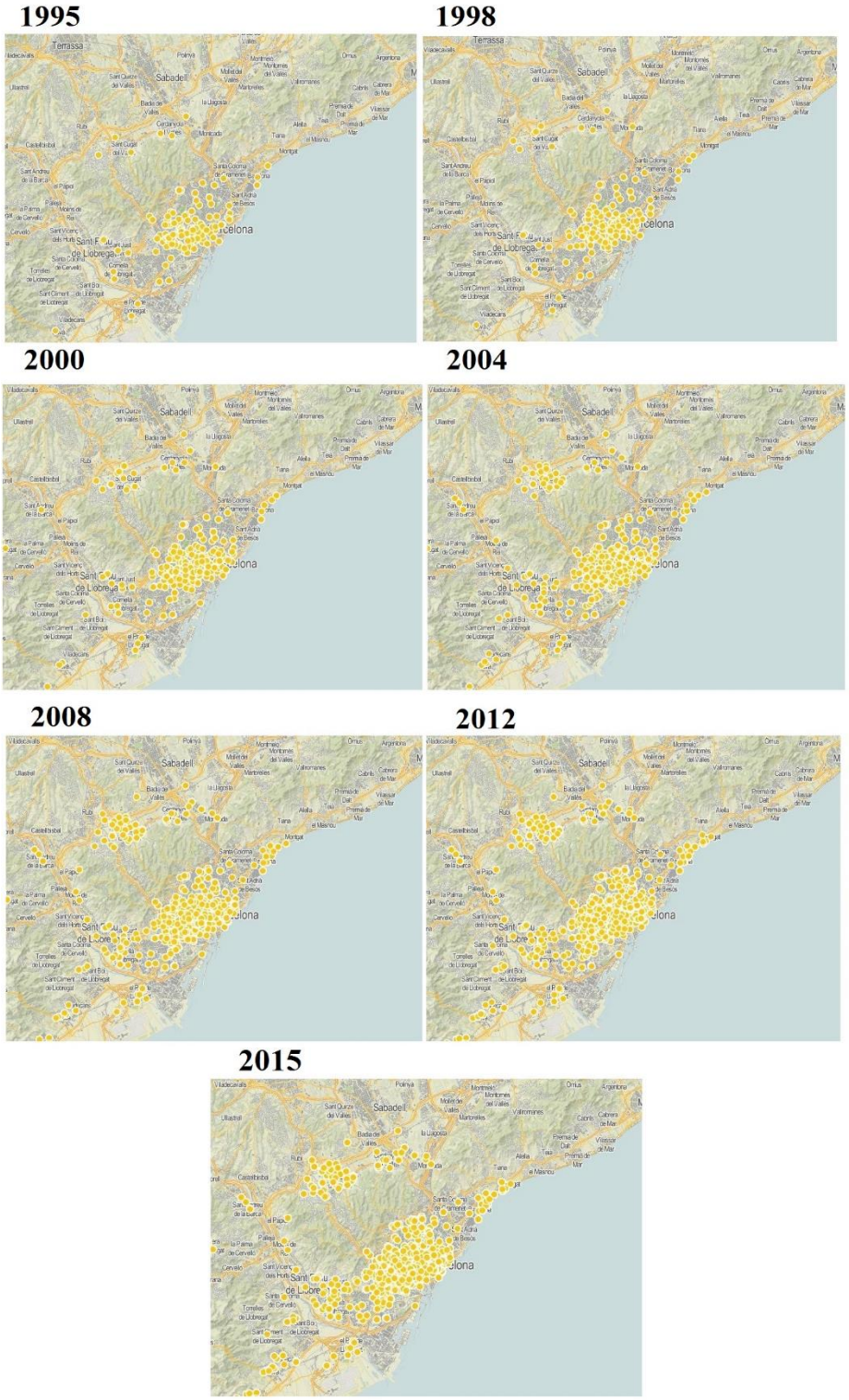
The expression above represents the spatial distribution of firms belonging to industry S_2 around industry S_1, evaluating whether the relative density of employees from one industry around employees of another industry is on average ($M_{S1,S2}(r) =1$), higher ($M_{S1,S2}(r) >1$) or lower ($M_{S1,S2}(r)<1$).

Likewise, and in the opposite direction, we can analyse the following expression:

$$M_{S_2,S_1}(r) = \sum_{i=1}^{N_{S_2}} \frac{\sum_{i=1}^{N_{S_1}} c_{S_1}(i,j,r)x_j}{\sum_{n=1,i\neq n}^{N} c(i,j,r)x_n} \Big/ \sum_{i=1}^{N_{S_2}} \frac{X_{S_1}}{X - x_i}$$

which represents the spatial distribution of firms belonging to industry S_1 around industry S_2, evaluating if the relative density of employees from one industry around employees of another industry is on average ($M_{S2,S1}(r)$ =1), higher ($M_{S2,S1}(r)$ >1) or lower ($M_{S2,S1}(r)$<1). In order to obtain a conclusive result, both values ($M_{S1,S2}(r)$ and $M_{S2,S1}(r)$) have to be in the same direction (both values higher than one indicates an agglomeration effect between industries, less than 1 a dispersion effect between industries, and both equal to 1 an average of employees across industries between them).

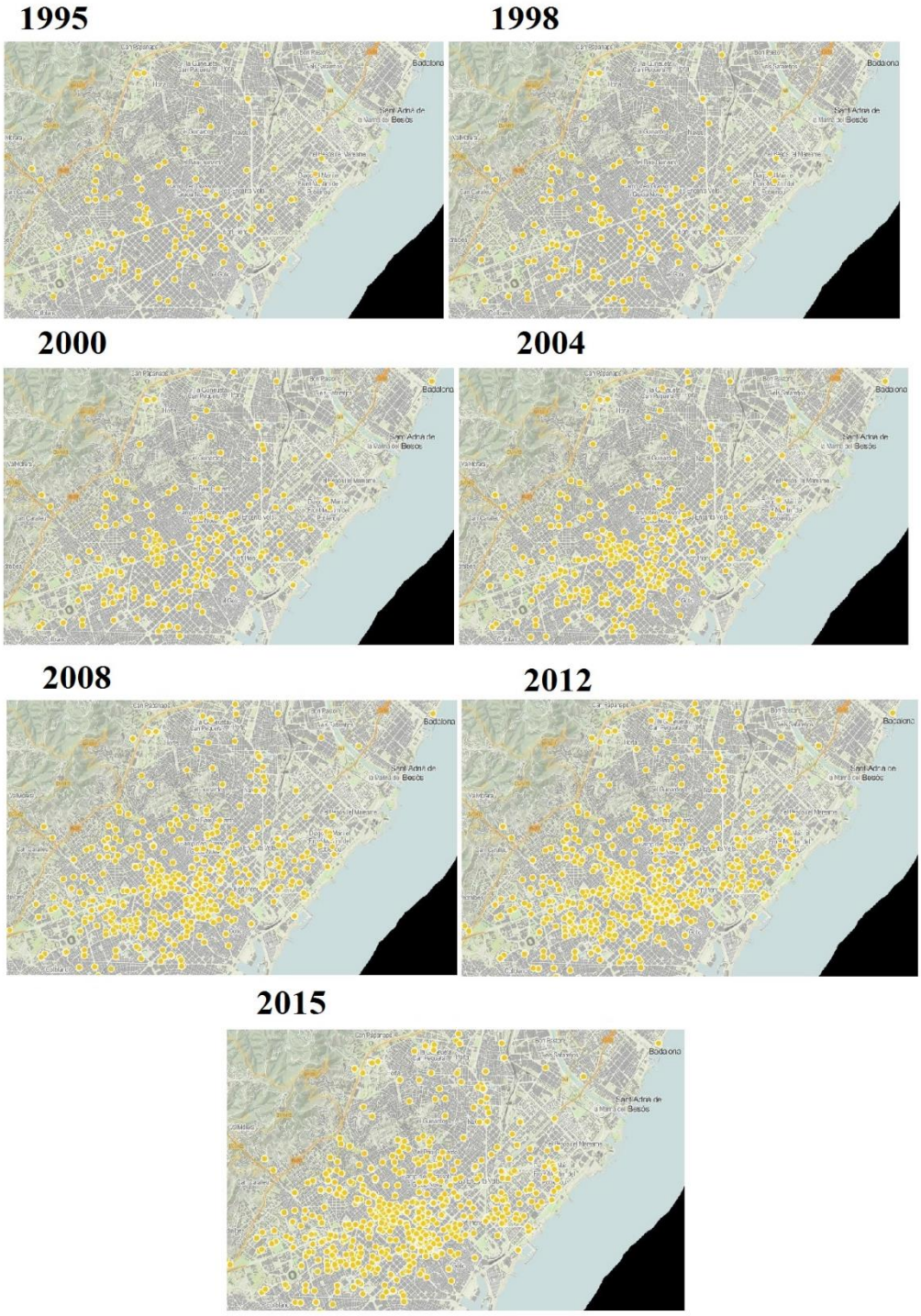
A1. Number of SVE firms in the MAB.



Year	1995	1998	2000	2004	2008	2012	2015
No. of firms	142	212	280	440	629	814	854*

*Firms with all data (See Table 2).

A2. Number of SVE firms in the city of Barcelona.



Year	1995	1998	2000	2004	2008	2012	2015
No. of firms	121	176	230	338	479	608	640*

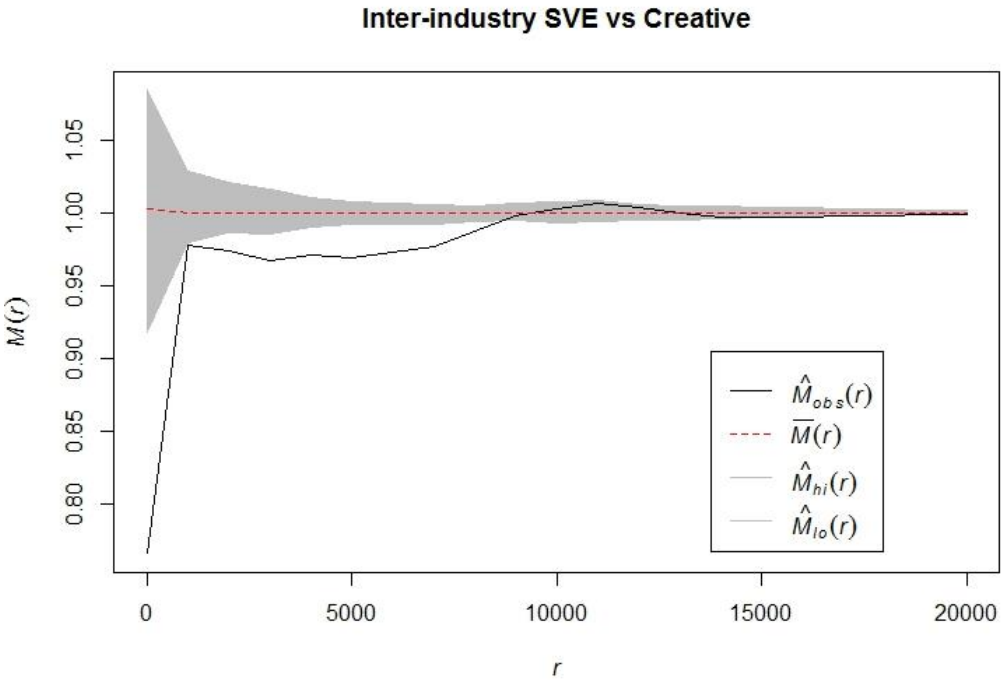
*Firms with all data (See Table 2).

Table A3. Neighbourhoods of Barcelona

Code	Name	Code	Name	Code	Name
1	el Raval	26	Sant Gervasi - Galvany	51	Verdun
2	el Barri Gòtic	27	el Putxet i el Farró	52	la Prosperitat
3	la Barceloneta	28	Vallcarca i els Penitents	53	la Trinitat Nova
4	Sant Pere, Santa Caterina i la Ribera	29	el Coll	54	Torre Baró
5	el Fort Pienc	30	la Salut	55	Ciutat Meridiana
6	la Sagrada Família	31	la Vila de Gràcia	56	Vallbona
7	la Dreta de l'Eixample	32	el Camp d'en Grassot i Gràcia Nova	57	la Trinitat Vella
8	l'Antiga Esquerra de l'Eixample	33	el Baix Guinardó	58	Baró de Viver
9	la Nova Esquerra de l'Eixample	34	Can Baró	59	el Bon Pastor
10	Sant Antoni	35	el Guinardó	60	Sant Andreu
11	el Poble Sec	36	la Font d'en Fargues	61	la Sagrera
12	la Marina del Prat Vermell	37	el Carmel	62	el Congrés i els Indians
13	la Marina de Port	38	la Teixonera	63	Navas
14	la Font de la Guatlla	39	Sant Genís dels Agudells	64	el Camp de l'Arpa del Clot
15	Hostafrancs	40	Montbau	65	el Clot
16	la Bordeta	41	la Vall d'Hebron	66	el Parc i la Llacuna del Poblenou
17	Sants - Badal	42	la Clota	67	la Vila Olímpica del Poblenou
18	Sants	43	Horta	68	el Poblenou
19	les Corts	44	Vilapicina i la Torre Llobeta	69	Diagonal Mar i el Front Marítim del Poblenou
20	la Maternitat i Sant Ramon	45	Porta	70	el Besòs i el Maresme
21	Pedralbes	46	el Turó de la Peira	71	Provençals del Poblenou
22	Vallvidrera, el Tibidabo i les Planes	47	Can Peguera	72	Sant Martí de Provençals
23	Sarrià	48	la Guineueta	73	la Verneda i la Pau
24	les Tres Torres	49	Canyelles		
25	Sant Gervasi - la Bonanova	50	les Roquetes		

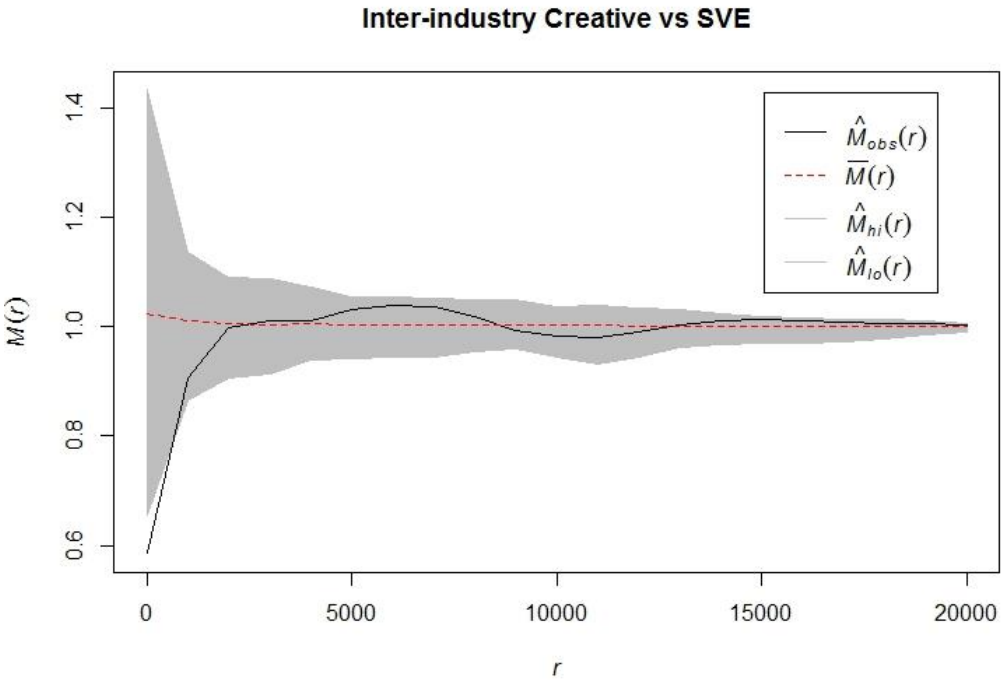
Source: *Barcelona City Council*.

Figure A4. Inter-Industry agglomeration: Software, Videogames and editing electronics vs. Creative in the MAB



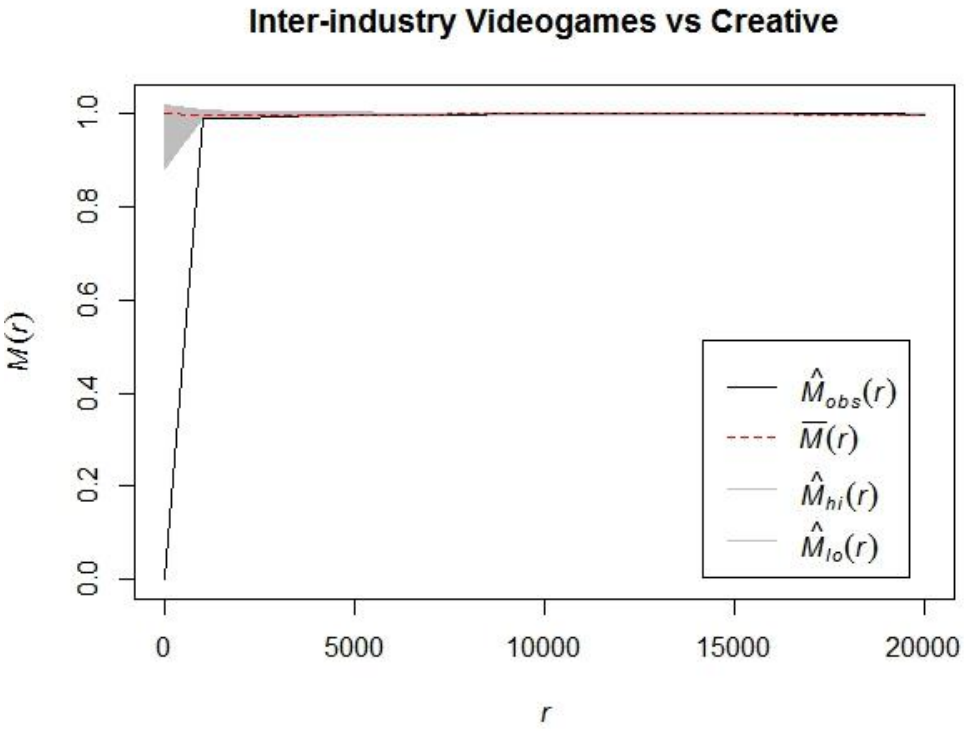
Horizontal axis units (r): meters.
Source: Compiled by the authors.

Figure A5. Inter-Industry agglomeration: Creative vs. Software, Videogames and editing electronics in the MAB



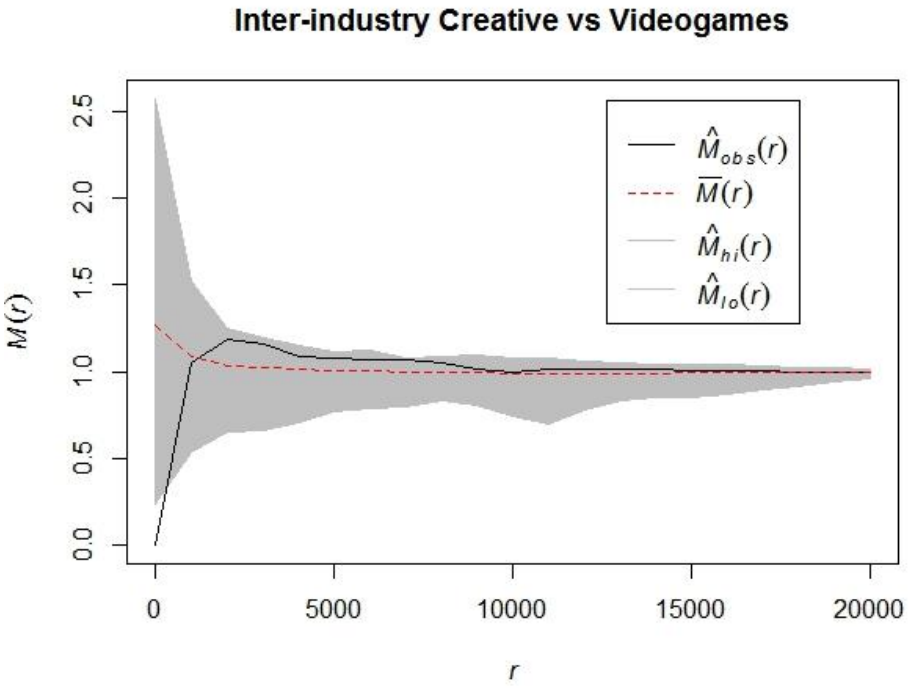
Horizontal axis units (r): meters.
Source: Compiled by the authors.

Figure A6. Inter-Industry agglomeration: Videogames vs. Creative in the MAB



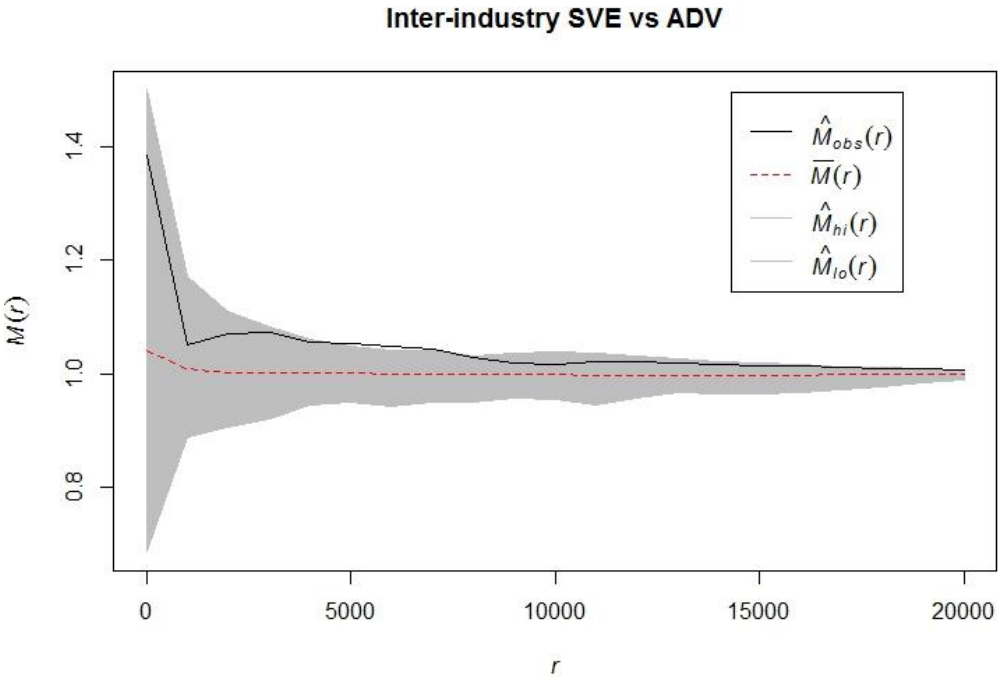
Horizontal axis units (*r*): meters.
Source: Compiled by the authors.

Figure A7. Inter-Industry agglomeration: Creative vs. Videogames in the MAB



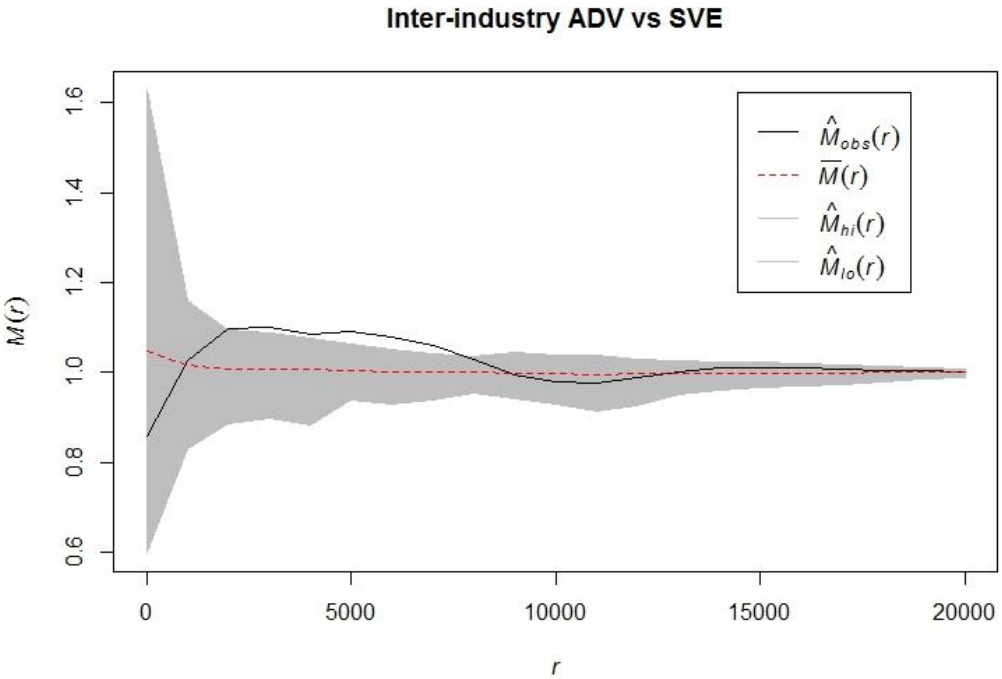
Horizontal axis units (*r*): meters.
Source: Compiled by the authors.

Figure A8. Inter-Industry agglomeration: Software, Videogames and editing electronics vs. Advertising and related services in the MAB



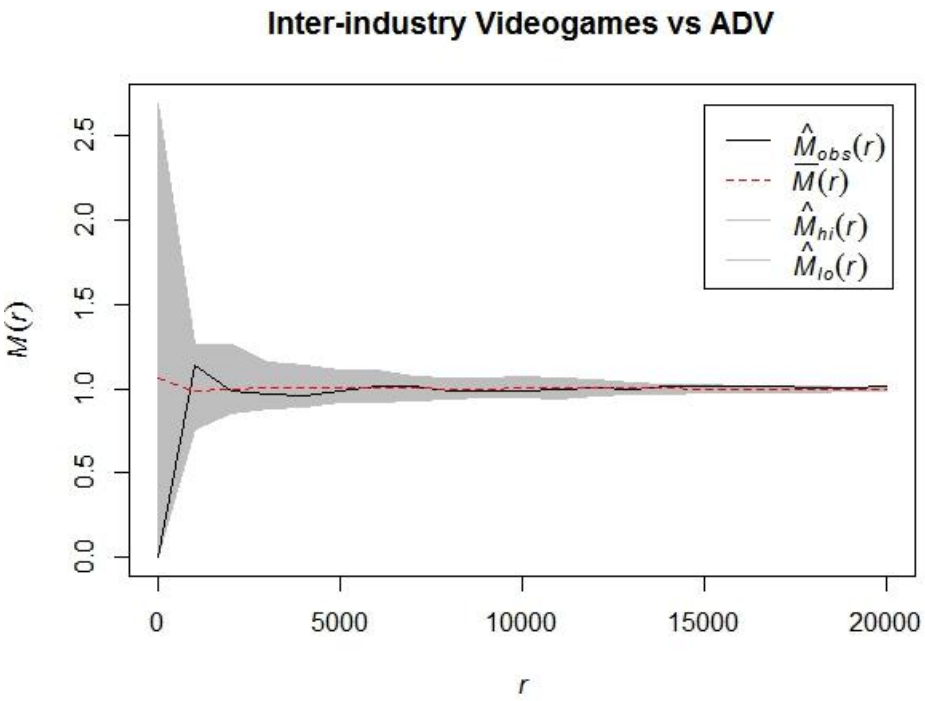
Horizontal axis units (r): meters.
Source: Compiled by the authors.

Figure A9. Inter-Industry agglomeration: Advertising and related services vs. Software, Videogames and editing electronics in the MAB



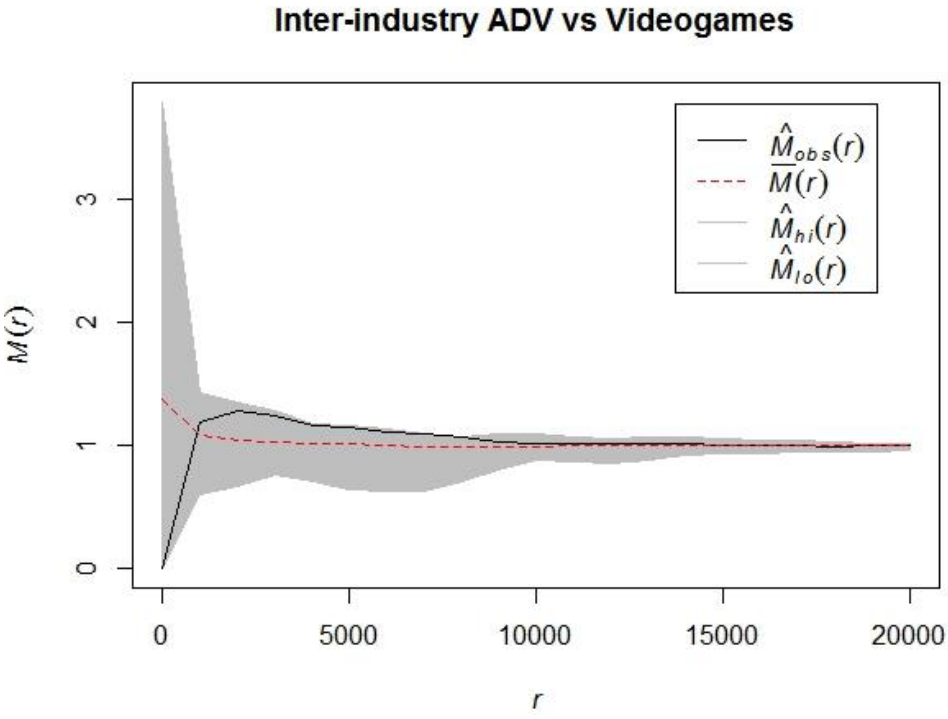
Horizontal axis units (r): meters.
Source: Compiled by the authors.

Figure A10. Inter-Industry agglomeration: Videogames vs. Advertising and related services in the MAB



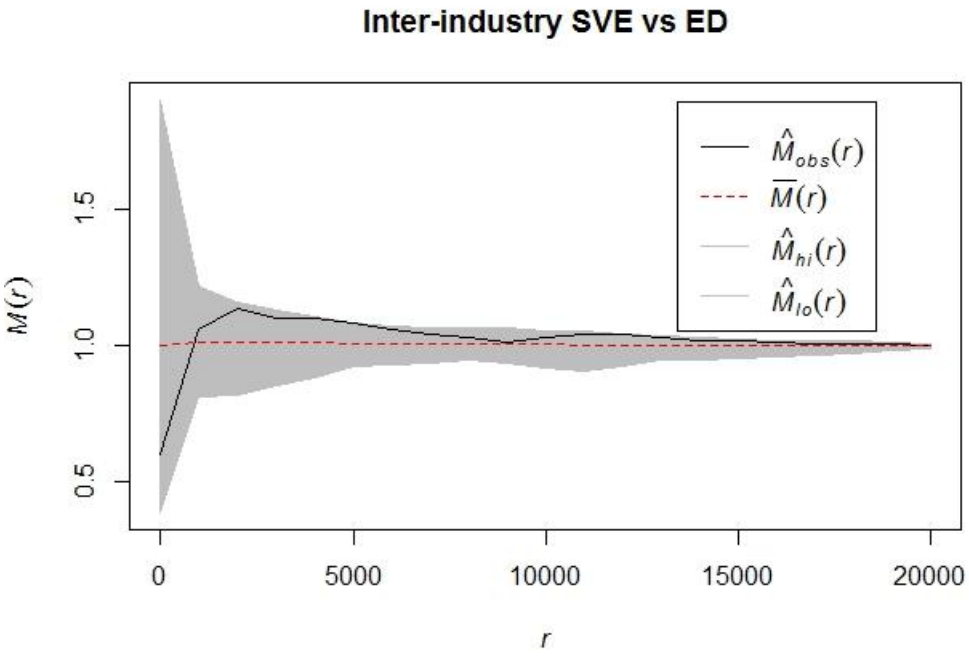
Horizontal axis units (*r*): meters.
Source: Compiled by the authors.

Figure A11. Inter-Industry agglomeration: Advertising and related services vs. Videogames in the MAB



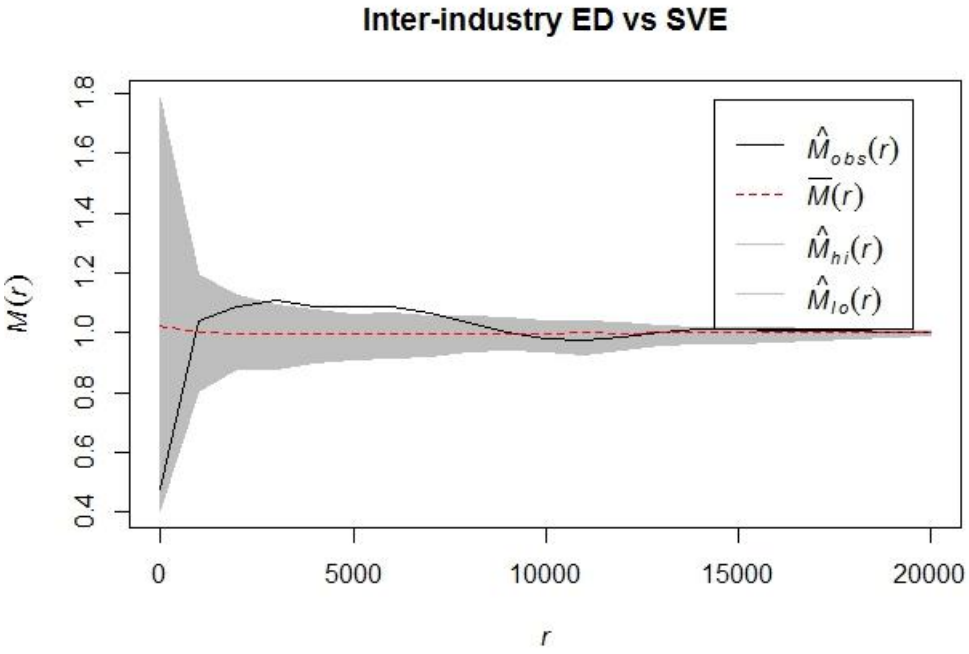
Horizontal axis units (*r*): meters.
Source: Compiled by the authors.

Figure A12. Inter-Industry agglomeration: Software, Videogames and editing electronics vs. Publishing in the MAB



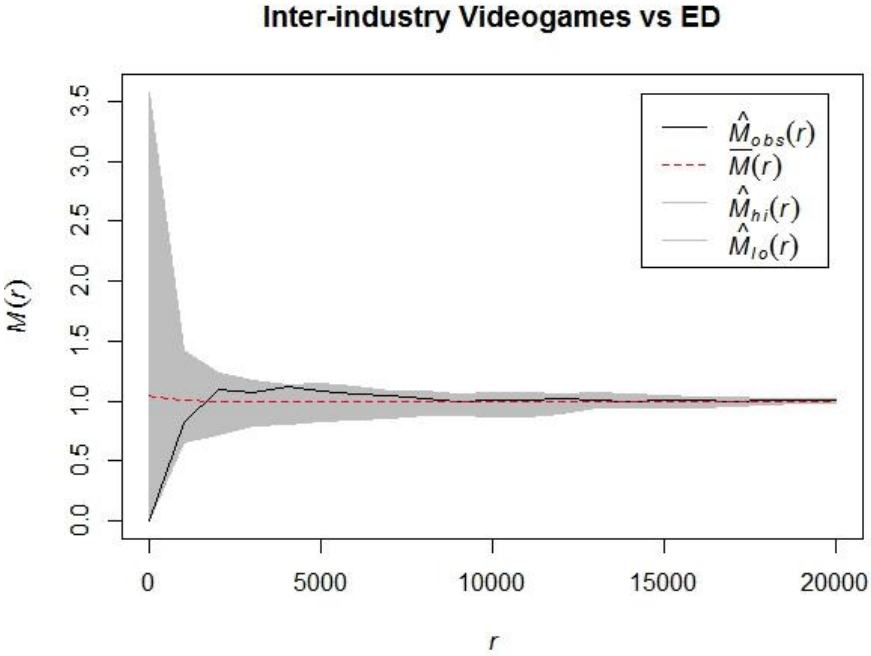
Horizontal axis units (*r*): meters.
Source: Compiled by the authors.

Figure A13. Inter-Industry agglomeration: Publishingvs. Software, Videogames and editing electronics in the MAB



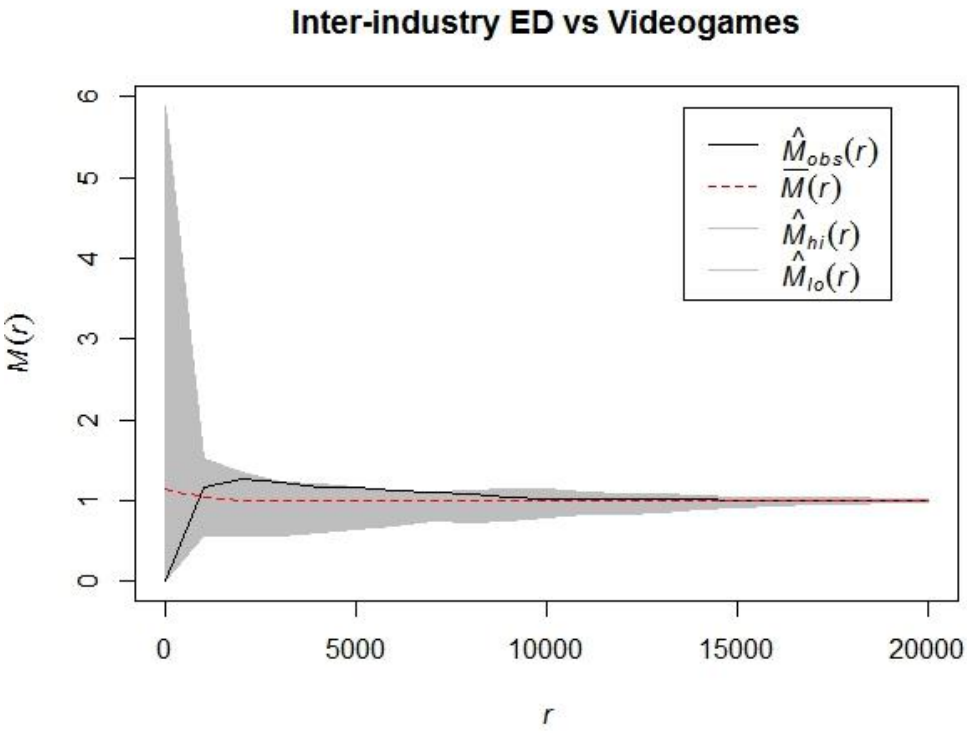
Horizontal axis units (*r*): meters.
Source: Compiled by the authors.

Figure A14. Inter-Industry agglomeration: Videogames vs. Publishing in the MAB



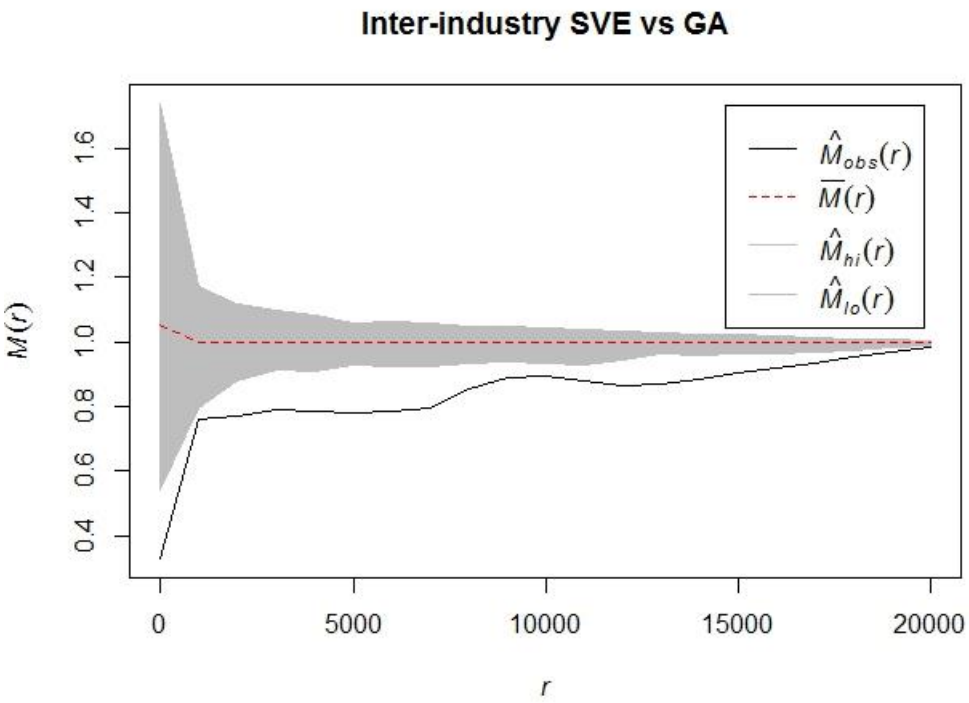
Horizontal axis units (r): meters.
Source: Compiled by the authors.

Figure A15. Inter-Industry agglomeration: Publishing vs. Videogames in the MAB



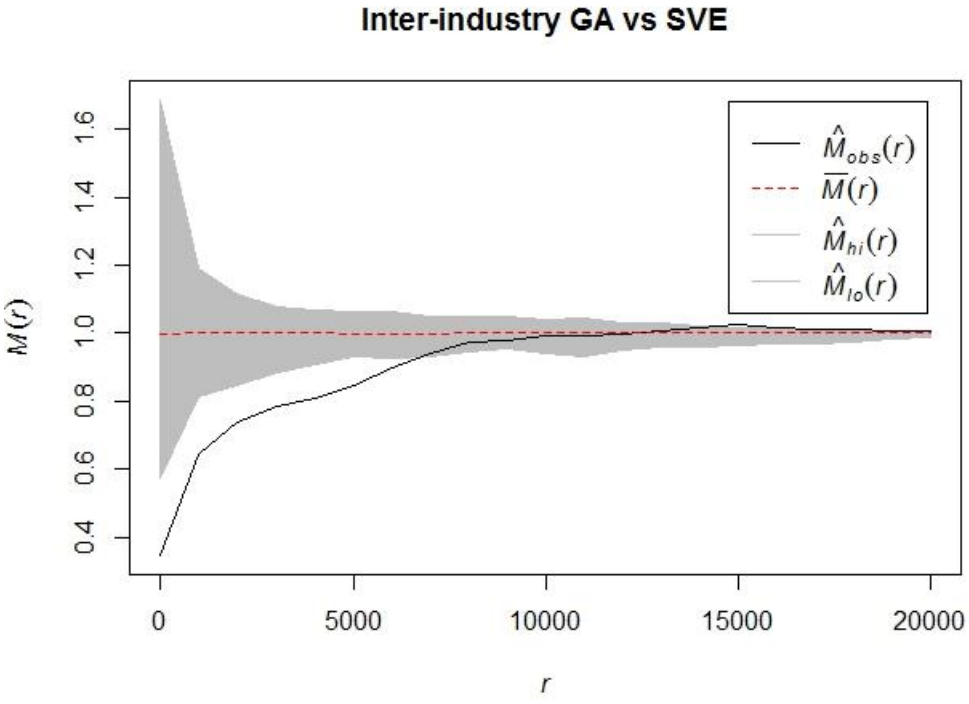
Horizontal axis units (r): meters.
Source: Compiled by the authors.

Figure A16. Inter-Industry agglomeration: Software, Videogames and editing electronics vs. Graphic Arts in the MAB



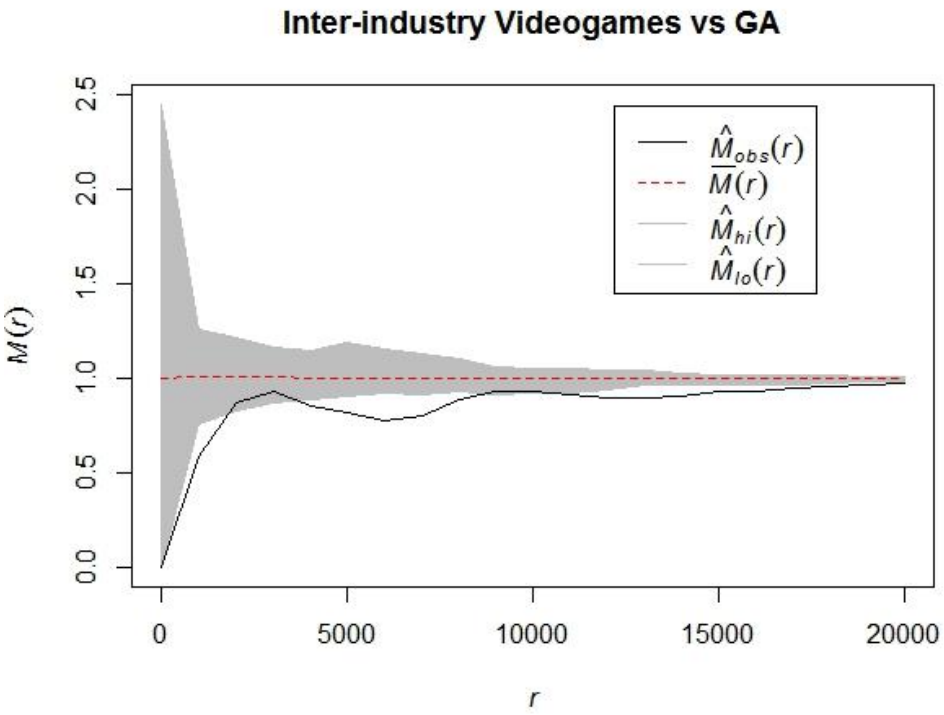
Horizontal axis units (r): meters.
Source: Compiled by the authors.

Figure A17. Inter-Industry agglomeration: Graphic Arts vs. Software, Videogames and editing electronics in the MAB



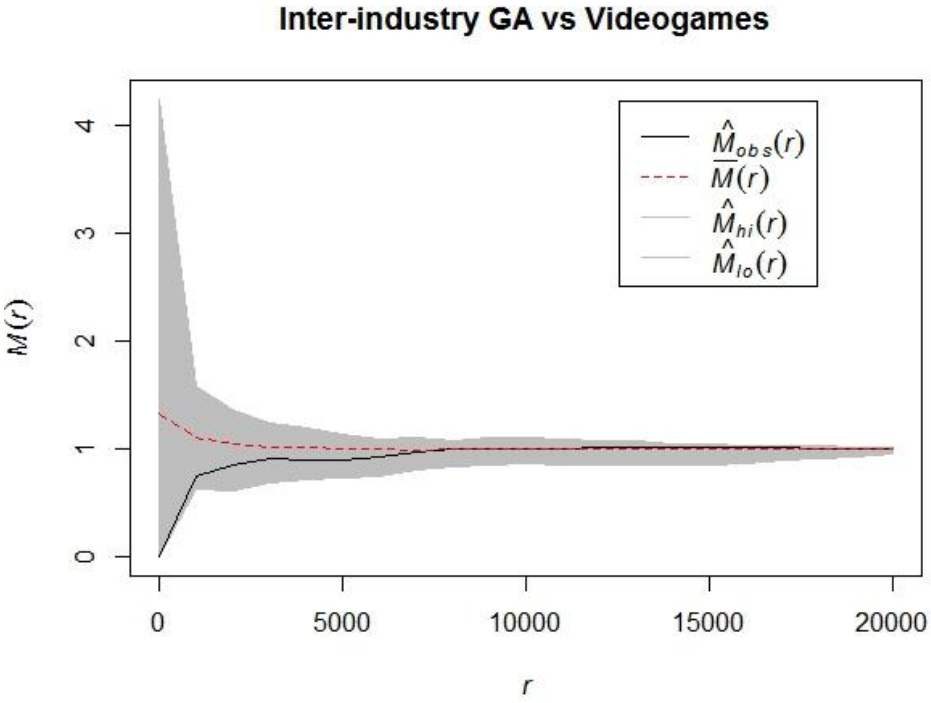
Horizontal axis units (r): meters.
Source: Compiled by the authors.

Figure A18. Inter-Industry agglomeration: Videogames vs. Graphic Arts in the MAB



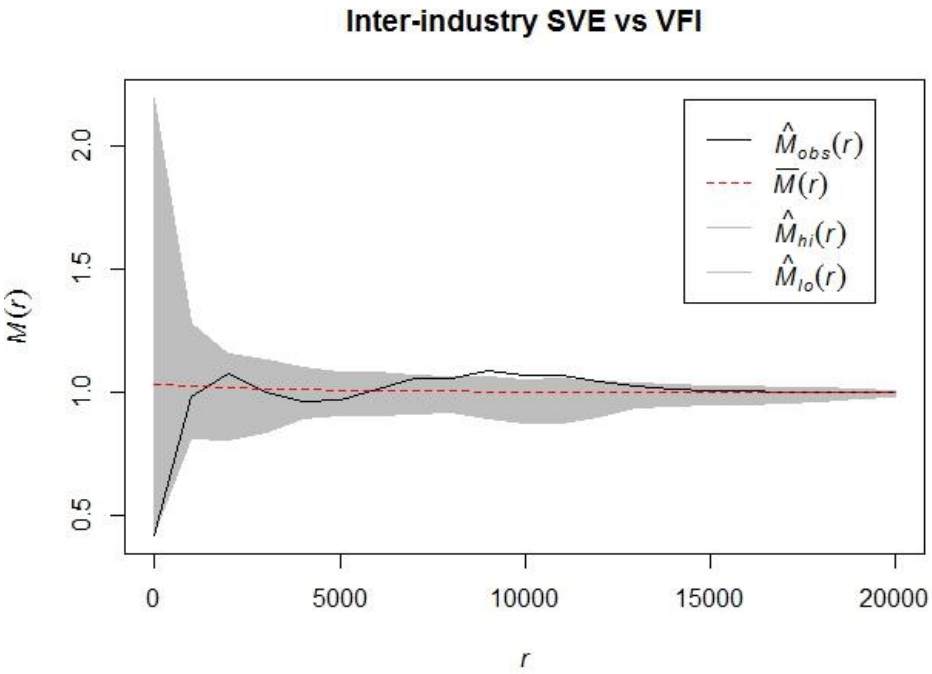
Horizontal axis units (r): meters.
Source: Compiled by the authors.

Figure A19. Inter-Industry agglomeration: Graphic Arts vs. Videogames in the MAB



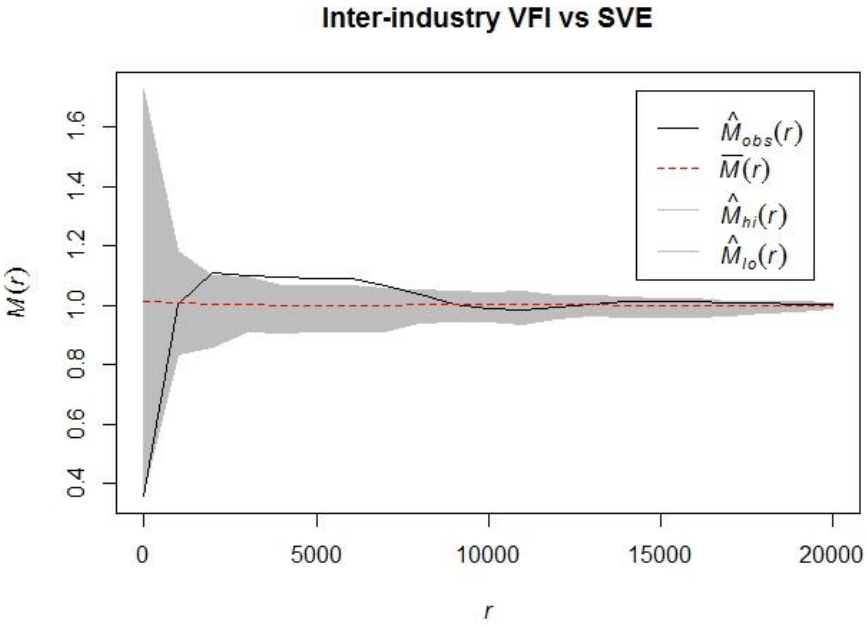
Horizontal axis units (r): meters.
Source: Compiled by the authors.

Figure A20. Inter-Industry agglomeration: Software, Videogames and editing electronics vs. Video and Film industries in the MAB



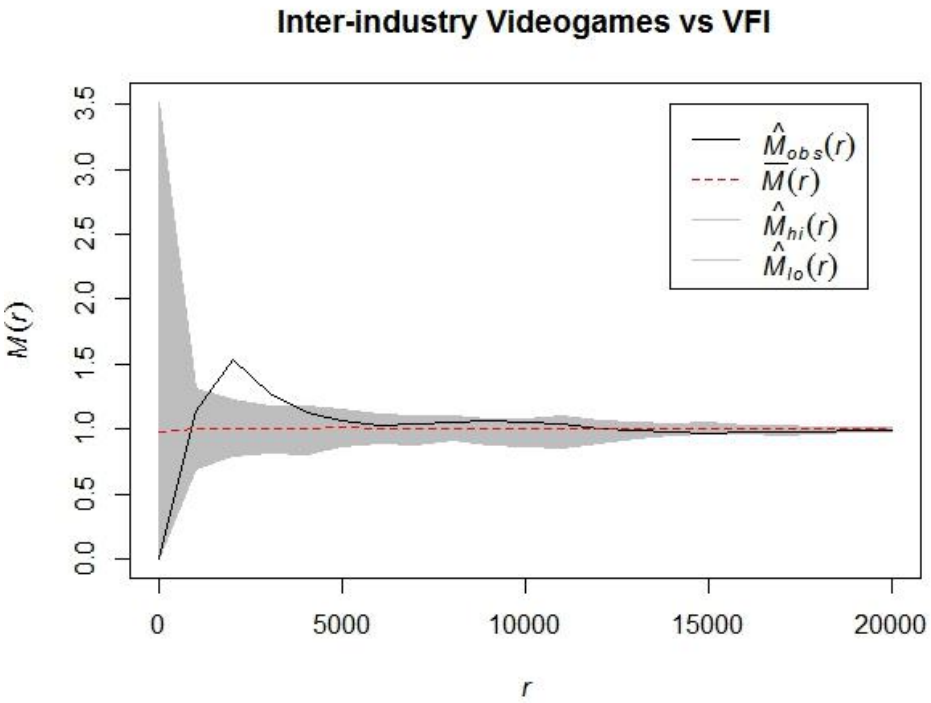
Horizontal axis units (r): meters.
Source: Compiled by the authors.

Figure A21. Inter-Industry agglomeration: Video and Film industries vs. Software, Videogames and editing electronics in the MAB



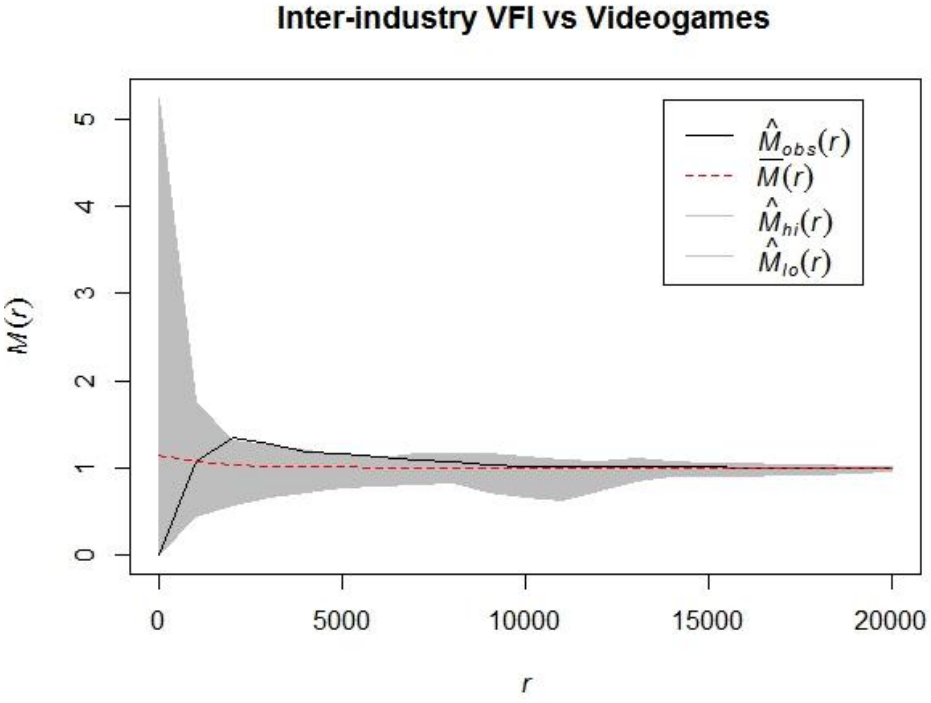
Horizontal axis units (r): meters.
Source: Compiled by the authors.

Figure A22. Inter-Industry agglomeration: Videogames vs. Video and Film industries in the MAB



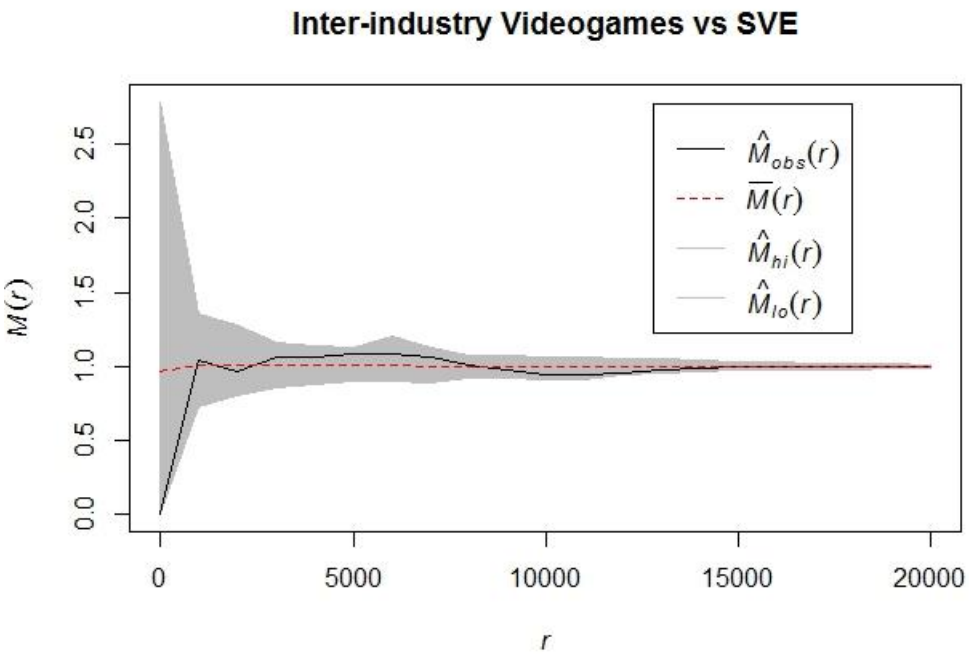
Horizontal axis units (*r*): meters.
Source: Compiled by the authors.

Figure A23. Inter-Industry agglomeration: Video and Film industries vs. Videogames in the MAB



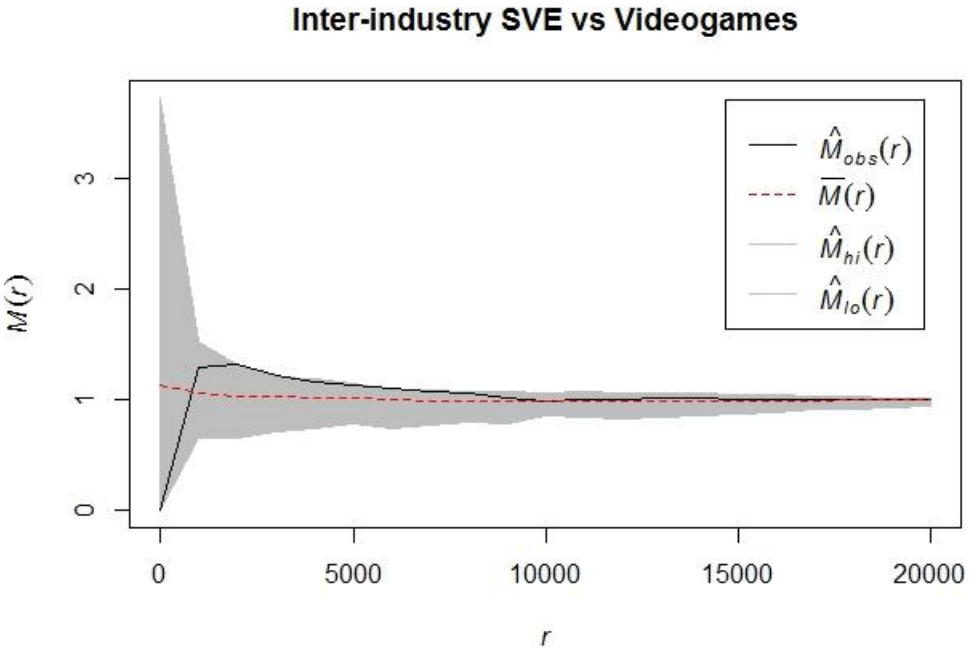
Horizontal axis units (*r*): meters.
Source: Compiled by the authors.

Figure A24. Inter-Industry agglomeration: Videogames vs. Software, Videogames and editing electronics (without Videogames firms) in the MAB



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

Figure A25. Inter-Industry agglomeration: Software, Videogames and editing electronics (without Videogames firms) vs. Videogames in the MAB



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