Creative clusters in Europe: a microdata approach

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Abstract. Creative industries are highly concentrated forming clusters. One of the main problems for the identification of clusters of creative industries in Europe is the lack of data, constrained in practice to regions (NUTS 2) and influenced by the heterogeneity in the definition of NUTS across countries. This research uses firm-level data geo-referenced at address level and geostatistical modelling to identify clusters of creative industries in sixteen European countries. The procedure is independent of administrative divisions and national boundaries and allows to produce a precise geography of the clusters of creative industries in Europe.

Keywords: creative industries, clusters, geostatistics
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1. INTRODUCTION

Creative industries tend to be highly concentrated in the space, even much more than the rest of activities (Lazzeretti et al. 2008). Geographical clusters and hot spots are a usual form of concentration of these industries. One of the main problems for the identification of clusters of creative industries in Europe is the limitation of data. In practice, this has constrained the identification of clusters of creative industries to:

a) Concrete case studies comparing two o more clusters using qualitative approaches, which gives only local evidence and are difficult to replicate for all the EU countries (e.g. Drake 2003);

b) The use of NUTS 2 regions (e.g. Power and Nielsén 2010), valid to detect very general and vague patterns of clustering, although too large and heterogeneous for the detailed detection of intra-regional and cross-regional clusters. Apart from the identification of global trends, the definition resulting from these data is too vague and incomplete;

c) Cross-country comparisons based on Census data (e.g. Lazzeretti et al. 2008; Boix et al. 2011) that are equally dependent on the definition a priori of the spatial unit and the laboured coordination of groups of research in several countries.

It is difficult to imagine how many cities and regions are enacting policy strategies based on clusters of creative industries based on vague definitions of their clusters, as well as how many are not aware of the existence of these clusters in their space. The other derived problem relies on the fact that it is difficult to elaborate precise and efficient European policy strategies for creative clusters without a detailed and comprehensive identification of the spatial clusters. Understanding how many possible clusters exist, where they are located, and their characteristics, is an effective way to target policies towards concrete objective of clusters and industries.

This research overcomes the limitation of regional and local statistics using firm-level data geo-referenced by address and geostatistical modelling to identify clusters of creative industries in sixteen European countries. We expect the results help to answer four questions: first, how much clustered are creative industries in Europe? Second, where are located the clusters and how much their distribution differs from the results from other methodologies? Third, do the patterns of clustering vary across creative industries? And fourth, which and where are the largest clusters?

The paper presents therefore two main novelties. On one hand, it presents a first attempt of detailed mapping exercise of clusters of creative industries in the EU. The procedure is independent of administrative divisions and national boundaries and allows to produce a precise geography of the clusters of creative industries in Europe. By doing like this, it provides new empirical evidence about the detailed patterns of clustering of creative industries in Europe. Second, it provides a flexible methodology that could

be applied to other countries or economic areas, as well as to other industries, in order to produce international comparisons.

The paper will proceed as follows: section 2 will present a review of the literature about clusters and creative industries. Section 3 presents the data and methodology. Section 4 explain and discusses the main results. Section 5 provides some concluding remarks.

2. CLUSTERS AND CREATIVE INDUSTRIES: A REVIEW OF THE LITERATURE

2.1. Creative industries

Creativity is the ability to combine data, perceptions and materials to produce something new. Creativity is not necessarily an economic activity although it can become when the result of the creative process is an idea with economic implications or a tradable product (Howkins 2007). In the **economic context**, creativity could be described as "an idea or action that is new or valuable" (Csikszentmihalyi 1996, p. 23) or the "formulation of new ideas and to the application of these ideas to produce original works of art and cultural products, functional creations, scientific inventions and technological innovations" (UNCTAD 2010, p.3). Thus, the **creative economy** refers to a holistic concept with complex interactions between culture, economics and technology in an economy dominated by intangible contents like symbols, texts, sounds and images (UNCTAD 2010, p.3).

The concept and definition of creative industries differs according to the approaches, necessities and practices in different countries and organisms. Thus, quoting only some of the most significant, the DCMS (2001, p.5) defines creative industries as "those industries which have their origin in individual creativity, skill and talent and which have a potential for wealth and job creation through the generation and exploitation of intellectual property". For the European Commission (2010) are defined as "those industries which use culture as an input and have a cultural dimension, although their outputs are mainly functional. They include architecture and design, which integrate creative elements into wider processes, as well as subsectors such as graphic design, fashion design or advertising". And for UNCTAD (2010, p.8) they are defined as industries that "(a) are cycles of creation, production and distribution of goods and services that use creativity and intellectual capital as primary inputs; (b) constitute a set of knowledge-based activities, focused on but not limited to arts, potentially generating revenues from trade and intellectual property rights; (c) comprise tangible products and intangible intellectual or artistic services with creative content, economic value and market objectives; (d) stand at the crossroads of the

artisan, services and industrial sectors; and (e) constitute a new dynamic sector in world trade".

Table 1. Classifications of creative industries

CREATIVE INDUSTRIES	DCMS 2009 (UK)	WIPO copyright industries (2003)	Eurostat LEG (2000)	KEA European Affairs (2006)	UNCTAD (2010)
Printing		X			X*
Publishing	X	X	X	X	X
Advertising & related services	X	X	X	X	X
Architecture	X	X	X	X	X
Arts and antique markets/trade	X	X			X
Crafts	X	X	X	X	X
Design / Specialized design services	X	X	X	X	X
Designer fashion	X	X			X
Film / Motion picture & video industries	X	X	X	X	X
Music / Sound recording industries	X	X	X	X	X
Performing arts (theatre, dance, opera, circus, festivals, live entertainment) / Independent artists, writers, & performers	X	X	X	X	X
Photography	X	X	X	X	X
Radio and television (Broadcasting)	X	X	X	X	X
Software, computer games and electronic publishing	X	X	X	X	X
Heritage / Cultural sites (Libraries and archives, museums, historic and heritage sites, other heritage institutions)			X	X	X
Interactive media			X	X	
Other visual arts (painting, sculpture)			X		X
Copyright collecting societies				X	
Cultural tourism / recreational services				X	X
Creative R&D					X

* Only used for statistical raisons in comparisons.

2.2. Spatial concentration of creative industries: a review of the literature

One of the main characteristics of creative industries is that they tend to be highly concentrated in the space, much more than the rest of the activity, and particularly in large cities and metropolitan areas (Lazzeretti et al. 2008; Boix et al. 2011).

The geographies of creative industries have relied on several territorial concepts and levels: creative regions (DCMS 2000; Cooke and Schwartz 2007), creative cities (Florida 2002; Landry 2000; Cooke and Lazzeretti 2008), local production systems (Lazzeretti et al. 2008; Sunley et al. 2008), creative clusters (Turok 2003; Pratt 2004) and creative milieux (Landry 2000) and quarters (Roodhouse 2006; Evans 2009).

The studies on creative clusters that focus on a particular creative industry are numerous and have used different methodologies. To give only some examples, Belussi and Sedita (2008) for the cluster music of Veneto, and Van Heur (2009) for London and Berlin have used network analysis to encompass the boundaries of the cluster. Turok (2003) focuses on the Scotland - Glasgow cluster of film and TV as a qualitative case of study. The film industry has been also studied for Los Angeles by Scott (2002) and De Propris and Hypponen (2008), using a mix of vertical-horizontal value chains and geographical analysis, and Kratke (2002) for Postdam/Babelsberg using network analysis. The same range of methodologies is applied for other studies on concrete creative industries such as Merlo and Polese (2006) and Wenting (2008) for the fashion industry clusters in Milan and Paris, and Pratt for the advertising industry.

The mapping exercises for an entire country are quite frequent in the United States. For example, Florida and Mellander (2008) study on the clustering of music industry in USA regions using location quotients, or Campbell-Kelly et al. (2010) using location quotients to study the patterns of geographical clustering in the metropolitan areas of the USA. However, these mapping exercises are very rare in the EU, particularly in comparative research. Capone (2008) provided a pioneer exercise of mapping of creative systems in Italy using local labour markets, an aggregation of creative industries based on DCMS, employment data, and location quotients. Lazzeretti et al. (2008) and Boix et al. (2011) extended this methodology in a comparative research on the location of creative industries in Italy, Spain, France and the UK. The same procedure was used by De Propris et al. (2009) for the UK using firm data, TTWA and Super Output Areas. Power and Nielsén (2010) provided the first attempt to produce a regional map of creative clusters in the EU using regions (NUTS 2) as unit of analysis and a constrained definition of creative industries due to the limitations of Eurostat data (Table 2).

At least three stylized facts regarding the geography of creative industries seem to emerge from these studies:

1. Creative industries are more concentrated in the space than the mean of the economic activity. Power and Nielsén report Gini indexes above 0.5 and up to 0.88 for about 60% of the creative industries in the EU regions. Boix et al. (2011) report for France, Italy, Spain and the UK Gini indexes between 0.76 and 0.91, and Gini indexes weighted by the total employment of about 0.75.

2. Creative industries tend to cluster in large and medium urban areas (Power and Nielsén 2010) and cities (Lazzeretti et al. 2008; Boix et al. 2011), although data for a more detailed geographical scale show richer patterns of concentration (De Propris et al. 2009). However, the scales or methodologies used on these researches fail in identifying the morphology of the clusters and their number.

3. London and Paris stand out by the number of jobs in creative industries (Power and Nielsén 2010; Boix et al. 2011). However, these researches don't identify the clusters inside the cities. Camors and Soulard (2010) and Freeman (2010) studies suggest that there are not one but several clusters of the same or different creative industries inside these cities.

Lazzeretti et al. (2011) provide a first integrated explanation for the general patterns of clustering of creative industries in the C-A-C model: culture and heritage, agglomeration economies, and creative class. The estimates of the model for Italy and Spain remark the power of urbanization economies in both countries and also the relevant contribution of localization economies and the creative class, whereas heritage is not decisive to explain the patterns of clustering. In addition, using the same framework, Boix (2011) found for the publishing industry in Spain that the co-localization with other industries of the value chain (in this case the printing industry) is another relevant factor that explains the concentration.

Table 2. Geographies of creative industries in EU countries at national or cross-country level

Authors	Spatial unit	Country	Industry definition	Method of identification	Data
Capone (2008)	Local Labour Markets	Italy	Creative industries adapted from DCMS (2001)	Location quotient	Employment
Lazzeretti et al. (2008)	Local Labour Markets	Italy and Spain	Creative industries adapted from DCMS (2001)	Location quotient	Employment
Boix et al. (2010)	Local Labour Markets	Italy, Spain, France and the UK	Creative industries	Location quotient	Employment
De Propris	Local	UK	DCMS (2009)	Location	Firms

et al. (2009)	Labour Markets and Super Output Areas			quotient	
Power and Nielsén (2010)	NUTS 2	EU 27	Constrained list of creative industries (cultural industries)	Location quotient	Employment

3. DATA AND METHODOLOGY

3.1. Data

The previous exercises of mapping have provided valuable information about the location and the patterns of location of creative industries in Europe. However, at this moment we are limited by two constraints. First, regions are too big to provide an appropriate detailed geography of the clusters of creative industries in Europe. The problems come from the average effects of regional units (ecologic fallacy), the possibility of several clusters of the same creative industry in the same region, the heterogeneity in the definition of NUTS 2 (some are small whereas others are huge), and the incapacity to provide the real location and boundaries of the clusters. Another question is the impossibility to detect cross-regional and cross-national clusters.

The second constraint has arisen when the strategy has been the collection of data at infra-regional levels (e.g. municipalities and local labour markets). Eurostat does not centralize this information and the only option is to collect them from the national statistical offices. The difficulty to access to the data, the monetary costs, and the process of learning to work with the national nuances of these data, lead in practice to found partners and to coordinate several national teams. This is also a difficult and slow process.

At this point, we want to move forward towards a methodology able to providing a high level of spatial detail and independent of administrative spatial units because of their constraints. For this raison, we use micro-data coming from Amadeus database. Amadeus provides data for all the EU countries, detailed by postal address, and four digits NACE Rev 2. This allows the maximum level of territorial detail and 4 digits NACE Rev 2. Whereas several years ago the number of registers included in the database was clearly insufficient, at this moment the number of firms and the significance of the sample is good enough to be used in geo-statistical algorithms. In addition, there is a discussion in the literature about the advisability of using data of employment or firms. Lazzeretti et al. (2008) and Clifton and Cooke (2009) provide arguments favourable to the use of employment data, whereas De Propris et al. (2009) choose the number of

firms. In the case of geo-statistical algorithms both levels are possible. The firm (individual) is a right unit for this kind of methodology (Sweeney and Feser 2003) and the information about the number of employees by firm is poor and irregular in Amadeus. For this raison we use the firm as basic observation for the procedure.

The database extracted from Amadeus and the EU 27 adds up to 966,000 000 firms in the UNCTAD (2010) list of creative industries (Table 1) that had some activity during the years 2001 to 2009. The postal address of the firm was translated to geographic coordinates which are used by the geostatistical algorithms. Unfortunately, there was only good cartography available at a postal address for 16 countries, so that the mapping only includes Austria, Belgium, Cyprus, Denmark, Finland, France, Germany, Greece, Italy, Luxembourg, Malta, Netherlands, Portugal, Spain, Sweden and the UK[4]. The initial sample for these countries was 780,000 creative firms. The data were treated and only those firms active in the year 2009 were included.

The sample was compared, when possible, with Eurostat SBS database (Table 3). The comparison is not exact for most of sectors as Eurostat data tend to be too aggregated so that they are oversized in relation to Amadeus sample. Furthermore, during the year 2009 there was an important mortality of firms due to the crisis that is not incorporated in Eurostat data. In any case, Amadeus/Eurostat ratio ranges from a minimum of 21% in architecture and engineering to a maximum of 105% in broadcasting. The average is above 29%, lower than, for example, Feser and Sweeney (2002) although the real coverage could be 5 to 10 points above. In any case, it is a substantial sample size. The controls by country don't give any evidence problems of over or undervaluation of any particular country, with the exception of Greece, where the sample is poor.

Table 3. Comparison of Amadeus 2009 data with Eurostat SBS 2008 data

	Amadeus 2009	Eurostat 2008	Amadeus/Eurostat
Fashion	35,615	120,967	29.4
Publishing	35,775	69,692	51.3
Film, video and music	44,290	78,510	56.4
Broadcasting (radio and TV)	9,661	9,127	105.9
Software and videogames (1)	113,843	392,097	29.0
Cultural commerce(2)	48,174	184,398	26.1
Architecture and engineering	163,670	760,390	21.5
Research and development	17,864	35,680	50.1
Advertising	65,765	193,588	34.0

[4] The rest of countries were excluded (Bulgaria, Czech Republic, Estonia, Hungary, Ireland, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia).

Total comparable	534,657	1,844,449	29.0
Other creative industries			
Design and Photography	22,506	-	5.7
Heritage	4,526	-	-
Performing arts	34,804	-	-

(1) Eurostat series includes all the sectors in computer programming, consultancy and related activities

(2) Eurostat series includes also commerce of recreational activities

Source: Amadeus and Eurostat SBS.

3.2. Methodology

Another key question is what definition of "cluster" we use. On the one hand, there is not strong evidence that creative industries as a whole performs like a productive chain and the lack of European input-output tables makes difficult to identify a commonly accepted chain[5]. If we use all the creative sub-sectors aggregated, probably we will rely more on the idea of "creative places" like in Lazzeretti et al. (2008) than on "creative clusters". This leads to the identification of the several clusters of creative industries one by one. On the other hand, we don't know a priori what is the chain of each creative industry in each location, and this is not completely consistent with the original idea proposed by Porter (1998) and refers to a particular definition of "cluster".

There is an intense discussion in the literature about this issue. The basic points are synthesized in Gordon and McCann (2000) and in the critical survey by Martin and Sunley (2003). Gordon and McCann (2000) distinguishes three forms of spatial clustering depending on the dominant or characteristic process in the cluster: "pure agglomeration", based on geographical proximity and agglomeration economies; "industrial complex", based on input-output linkages and co-location in order to minimize transactions costs; and "social-network", based on high levels of embeddedness and social integration.

Martin and Sunley (2003 p.19) remark that the vagueness of the concept does not lend to easy or precise delimitation, so that "there is no agreed method for identifying and mapping clusters, either in terms of the key variables that should be measured or the procedures by which the geographical boundaries of clusters should be determined". Among the several problems that usually arise in the empirical delimitation of clusters, the authors remark the identification of the cluster core industries, the lack of

[5] We refer to DCMS (2007) and UNCTAD (2010) to a discusión about the different approaches to this question. In particular the DCMS Frontier Economic model could be a point of departure to the elaboration of a functional creative chain for each creative industry.

inter-industry trade data for sub-national geographical areas, the collection of data on the basis of pre-given administrative and political units, the difficulties to identify the geographical boundaries of the clusters, the selection of data (employment, firms, added value, productivity) and the arbitrariness of the rules to distinguish clusters.

The most usual procedures to identify industrial clusters are synthesized in Bergman and Feser (1999): path dependency, expert opinion (Delphi, MSQA), a critical mass of firms in a region of the same or complementary sectors, concentration indexes (location quotients, Gini indexes, Ellison-Glaeser measures), input-output (triangularization, factor and principal components analysis), and network analysis. Combinations of several procedures are possible in a multidimensional perspective (Brachert et al. 2011). Feser and Sweeney (2002) extend the range of methodologies to incorporate spatial statistics.

In spatial statistics, we can basically distinguish between discrete versus continuous space, and global versus local and focused indicators derived from first and second order statistics (Feser and Sweeney 2002; Jacquez 2008). Discrete space requires the use of previous delimitated spatial units (lattices), usually administrative units, whereas in continuous space that is not necessary. Global indicators give information about the general trends of clustering although they don't provide information about where are the clusters.

Local/focused methodologies in continuous space are also named hot spot procedures. There are dozens of hot spots techniques, grouped in six typologies (NIJ 2004): point locations (total number of cases, e.g. fuzzy mode), hierarchical (grouping hierarchically the cases, e.g. nearest neighbour methods), partitioning (partitioning the sample in groups, e.g. spatial k-means), clumping (partitioning techniques with overlapping), density (density of cases, e.g. kernel methods), and risk-based (weighting by a risk variable such as population, e.g. Kulldorff scan). The different techniques have different uses and solutions and reveal different clustering patterns.

Thus, the quantitative procedure we propose in this research is closer to the category of "pure agglomeration" as the final results are hot spots of sector-by-sector creative industries. However, this choice could be not far from the reality, as the findings by Lazzeretti et al. (2011) suggest that the main forces explaining the concentration of creative industries are the agglomeration economies.

The methodology we propose shows some parallelisms with the stages followed by Crouch and Farrell (2001) for the general identification of clusters, and Capone (2008) and De Propris et al. (2009) for the identification of creative local systems:

1. A list of creative industries is proposed. Each industry is considered separately as the objective is to distinguish clusters of creative

industries and not creative places. In this case we followed the UNCTAD (2010) definition (Table 1).

2. The basic observation is the firm. The data are extracted from the database, treated and geo-codified transforming the postal addresses in geographical coordinates. The significance of the sample is controlled by comparing the data by country with Eurostat SBS database.

3. A geo-statistic algorithm is selected, in this case the spatial nearest neighbour hierarchical clustering (NNHC), and the procedure runs on each creative industry separately. The technique was selected due to some properties we found more advantageous than other methods: first, it works well with a very large number of observations in a continuous space, as is our case. Second, it does not need to reduce the space to grids, as for example do the kernel techniques, so that avoids the selection of the size of grids (Sweeney and Feser 2003). Third, it is possible to select a threshold random distance for the firms in the cluster so that avoids to fix it manually. Fourth, it does not need to assume any shape for the search radius as in the scan methods; it can detect large clusters and very small clusters, even inside cities; finally, it is possible to obtain the enveloping line of the cluster (Table 4).

Table 4. Properties, advantages and limitations of the methodology

Properties	**Desirable** (based on Martin and Sunley 2003; Bergman and Feser 1999; Feser and Sweeney 2003)	**Effective in our study**
Procedure	Several possibilities	Geostatistical algorithm
Rationale	Agglomeration + Complex + Social network	Agglomeration
Chain (linkages)	Vertical and horizontal	Horizontal
Boundaries	Flexible and independent of administrative units and scales	Flexible and independent of administrative units and scales
Direction	Top-down, bottom-up or both	Bottom-up
Data	Independent of geographical boundaries. Usually firms or employment.	Microdata independent of geographical boundaries. Firms by postal address and sector.
Technique	Qualitative, quantitative or both	Quantitative
Spatial morphology	Flexible	Flexible
Results	Robust. They prove the existence of the cluster	Weak. Suggest the existence of the cluster

3.3. Spatial nearest neighbour hierarchical clustering

The spatial nearest neighbour hierarchical clustering (NNHC) (NIJ 2004) defines a threshold distance that is compared for all pairs of points and then iterates to aggregate, first pairs none isolated points in clusters (Figure 1).

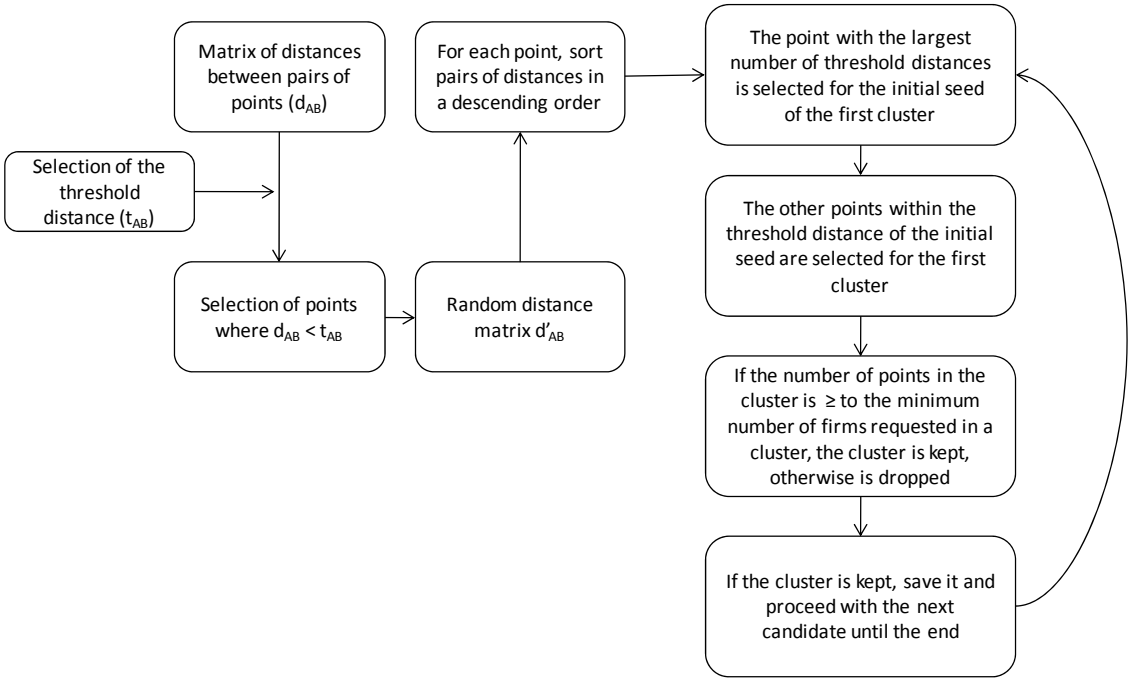
In the first step, those points closer to other points in the threshold distance are selected and the rest removed. It is possible to manually select the distance threshold, although there is not an agreement about the distance radius in clusters. For example, Fundenburg and Boarnet (2008) found an average of 5-7.5 miles in their study of manufacturing clusters in Southern California, Feser and Sweeney (2002) a distance of 26 kilometres for manufacturing industries in San Francisco Bay area and May et al. (2001) a range up to fifty miles for the British high-fidelity industry. Rosenthal and Strange (2004) argue that the spatial range of agglomeration economies is small for localization economies in agglomerated industries, falling up to 15 miles, whereas urbanization economies could extend hundreds of miles.

An option to avoid the problem is to select as a threshold the random distance to the nearest neighbours that is based on the probability of selecting any pair of points on the basis of a random distribution. Most of the software packages (e.g. ArcGis, Crimestat) computes the mean random distance to the first neighbour ($0.5\sqrt{\frac{A}{N}}$) due to the fact that it is easy to relate it on a confidence interval defined for a specific one-tailed probability and to compare it with Student t tables. However, the hypothesis that firms are related only with the nearest single firm in the cluster is unreal and we should select a number of *n* nearest neighbours with which a firm could be linked.

Unfortunately, as the high-order pairs are correlated, it is not possible to fix an a priori level of statistical significance and calculating the radius departing from this level for more than the fourth neighbour (Aplin 1983). Several solutions have been suggested in the literature (see Dixon 2006 for a synthesis), none of them definitive: Kolmogorov-Smirnov type statistics using Monte-Carlo tests, squared distances, graphical methods, and the use of auxiliary functions like Rypley's K.

We propose a two-steps method, based in the previous calculation of the K-order nearest neighbour (NJI 2004) and then using this distance in the algorithm. As we fixed the minimum number of firms in a cluster in 50, we calculated the mean real distance $d(K_{NN})$ and the mean random distance $d(K_{ran})$for an order of 50 neighbours $(d(K_{ran}) = (K(2K)!)/((2^k K!)^2\sqrt{N/A})$ and then calculated the Nearest Neighbour Index as $NNI = d(K_{NN})/d(K_{ran})$. For each point, the NNI compares the average distance from the closest neighbour with a distance that is based on chance. The figure 2 shows than the NNI index increases very fast for the first neighbours (indicating than the interaction decreases at each step) and then becomes more stable (indicating that additional neighbours have a reduced impact). The point of inflexion indicates the possible boundaries of the cluster.

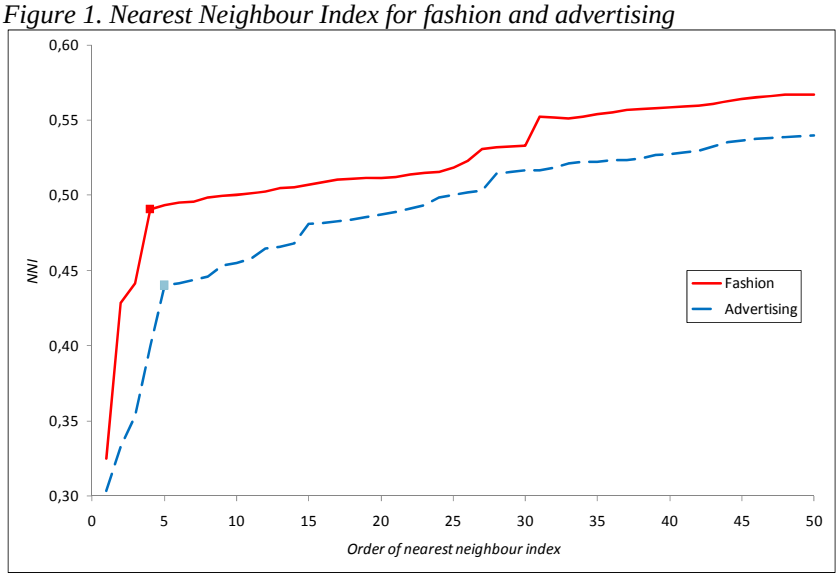
Figure 1. Spatial nearest neighbour hierarchical clustering algorithm



This procedure has the advantage that we obtain a distance for each creative industry and that we can examine the spatial patterns in order to detect anomalies. The main disadvantage is that we cannot establish with detail the statistical significance of the probability of clustering. We only know that if the NNI is below 1 then the observed average distance is smaller than the mean random distance and this provide evidence of clustering. The lower is the NNI index, the higher the robustness of clustering patterns.

We compared the results of the point of inflexion with those for the first and the 50th neighbour. The first one produces a large number of extremely small microclusters (in our trials, of a radius of 1 to 2 kilometres) whereas the second one tends to merge medium-sized clusters that are independent to produce macro-clusters. The inflexion point produces the most satisfactory results[6]. This also points out that, in general, there is not a unique solution and the distance for clustering depends on the scope of the research.

Figure 1. Nearest Neighbour Index for fashion and advertising



After the selection of the distance, the algorithm iterates to form the clusters on the basis of their closeness to previous groups in a hierarchical (aggregative) way. A convex hull (an irregular polygon) is calculated as the

[6] We compared the results with other researches, as for example the maps of industrial districts in Italy, Spain and the UK in the case of the fashion industry. The results prove to be quite satisfactory.

enveloping line to the points of the cluster, so that we can identify basic features as the area of the cluster.

Finally, as the number of firms in the cluster ranges from 2 to N. This number introduces certain arbitrariness since there is not any rule about what is the minimum number of firms in a cluster. We come to an agreement of more than 50 firms in a cluster in order to reinforce the results[7]. The technique has some other limitations, for example, the only rationale behind the clusters is the distance between firms, supported on the theory of agglomeration; the lack of a criterion to decide how many firms are included in the cluster; and the distribution of creative firms is not contrasted against the distribution of the rest of the activity, even if this could be done introducing a risk-adjusted NNHC (however, this leads to work with tens of millions of firms).

4. RESULTS: CLUSTERS OF CREATIVE INDUSTRIES IN THE EU COUNTRIES

The final result is a map of pure agglomeration clusters or hot spots for each creative industry, producing a detailed geography of creative clusters in Europe that is independent of geographical boundaries. In many senses, this procedure overcomes most of the limitations pointed out by Martin and Sunley (2003), particularly those associated with the spatial dimension of the cluster although its main weakness is that the productive chain of each creative industry is not identified a priori for each cluster.

The number of neighbours for the calculation of the radius varies from 3 (research and development) to 13 (engineering), although the mean and median is about 7. The mean random distance for the boundaries of the clusters ranges from 8.4 (advertising) to 34 kilometres (design) and the average is 16.5 kilometres, which is not very different from Fundenburg and Boarnet (2008) or Rosenthal and Strange (2004).

Now we can put some light on the research questions. The first one is ***how much clustered are creative industries in Europe?*** They are highly clustered. We identified 1,784 clusters across 15 creative industries. The average number of clusters by industry is 119 and varies from 10 (heritage) to 358 (engineering). About 61% of the firms of the sample are located in clusters or hot spots. These results are in line with those of Lazzeretti et al. (2008) and Boix et al. (2011), where the creative local systems concentrated between 63 and 71% of the employment in creative industries.

[7] Some trials have been performed to introduce an automatic criterion based on knee techniques, which suggested a number of firms above 0.025% of the sample, although the results are not very different and the absolute value is easier to interpret.

The most clustered industries are film, video and music; software, cultural trade, engineering, videogames, design, and architecture, where more than 60% of the firms are in clusters (Table 5). Only in Photography, R&D and Heritage more than 50% of the firms are not clustered.

Table 5. Main results

	k-order	random distance in metres	Clusters	Firms by cluster	Total firms sample	% of firms in clusters
Film, video and music	5	10,283	90	30,021	44,290	67.8
Software	10	10,084	313	63,849	94,433	67.6
Cultural trade	11	14,825	82	31,421	48,174	65.2
Engineering	13	11,385	358	62,593	96,876	64.6
Videogames	6	17,087	78	12,451	19,410	64.1
Design	10	34,011	26	5,118	8,302	61.6
Architecture	8	10,691	241	40,211	66,794	60.2
Performing arts	6	12,760	87	20,317	34,804	58.4
Advertising	5	8,439	178	37,596	65,765	57.2
Publishing	7	13,635	92	20,431	35,775	57.1
Fashion	4	10,193	102	19,781	35,615	55.5
Broadcasting	7	26,238	23	5,220	9,661	54.0
Photography	10	24,633	45	7,018	14,204	49.4
R&D	3	12,336	59	7,573	17,864	42.4
Heritage	5	32,168	10	1,089	4,526	24.1
TOTAL	-	-	1,784	364,689	596,493	61.1
AVERAGE	7	16,585	119	24,313	39,766	56.6

The second question is ***where are located these clusters, and how much their distribution differs from the results found using regional data and the most usual methodologies such as location quotients?*** The figure 3 show that creative clusters are distributed across all the European territory, even if there are impressive concentrations in the South oh England, Île de France, and the Benelux.

A comparison with the map of the figure 4 makes evident the differences. This second map has been elaborated using a typical quantitative procedure based on Eurostat NACE 2 data (number of firms by creative industry) and a location quotient above 1 (see similar applications in Lazzeretti et al. 2008; De Propris et al. 2009; Power and Nielsén 2010; Boix

et al. 2011). This second map is subject to several problems related to the Modifiable Areal Unit Problem (MAUF), as for example that is unable to found more than a point by industry and region, it cannot indicate in what part of the region is really located each cluster, it emphasizes the relevance of countries with smaller regions (e.g. Germany), and cannot found some clusters if the share of the industry in the region is not large enough to be remarked by the location quotient. In addition, the spatial patterns also differ and the firs map (figure 3) shows a precise and detailed geography of creative industries in Europe which is much more interesting and attractive regarding policy strategies.

The differences are even more evident industry by industry. The figure 5 provides the detail for fashion and software industries. The LQ methodology with regional data identifies the importance of fashion in Italy and the north of Portugal but produce very imprecise information about the spatial patterns. The NNHC procedure with microdata show a largest number of clusters, their size and distribution, and succeeds in identifying important clusters in the east cost of Spain, the north of Italy and Paris, as well as other clusters hidden by the other methodology. The case of software is even more evident, since the LQ methodology only highlights important patterns of clustering in Germany, the Benelux and the south of England. However, the NNHC methodology identifies clusters in many other countries and remarks that Paris hosts the largest cluster of software in Europe.

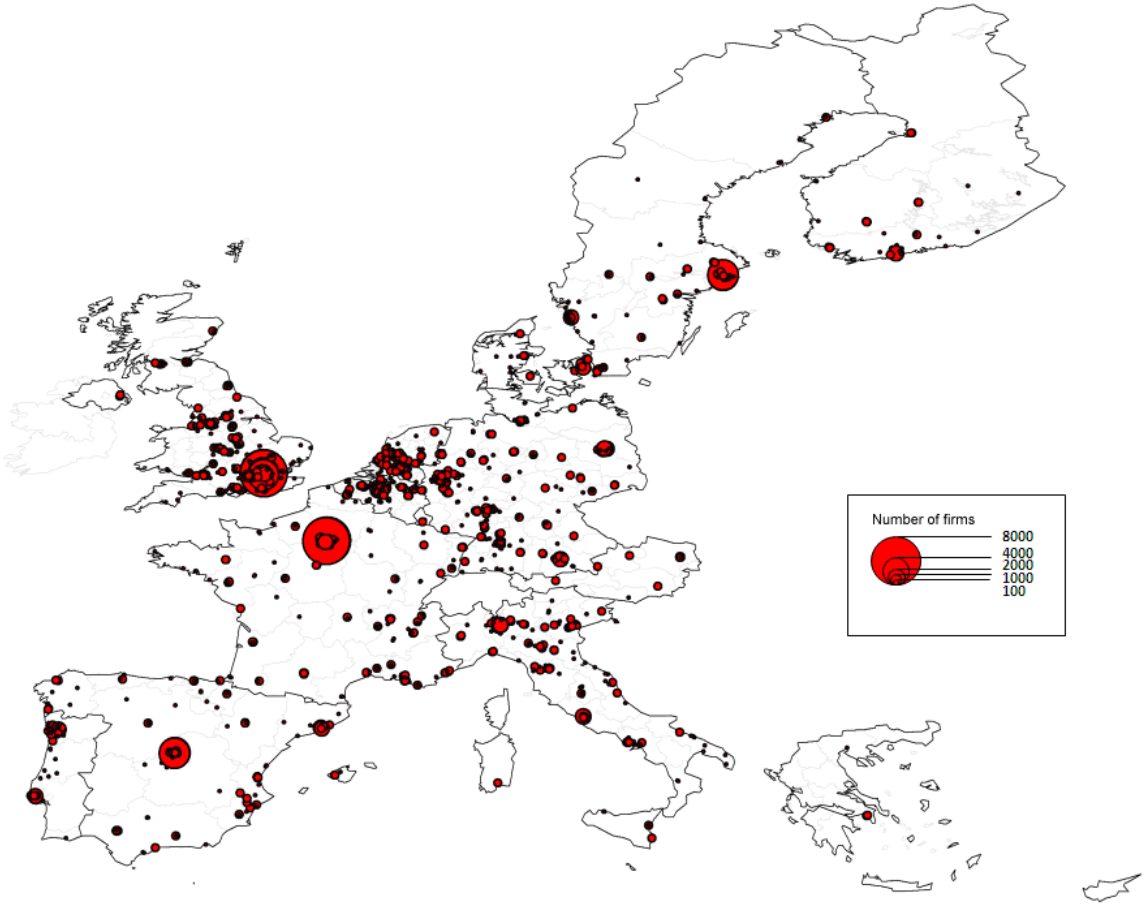
The third question is if ***different creative industries show different patterns of clustering***. The figure 5 provides again a clear example comparing fashion and software. Whereas fashion clusters tend to be concentrated in Mediterranean countries, software clusters are more dispersed and particularly important in an ellipse that encompasses the south of England, north of France, west part of Germany and the Benelux. The detailed maps for the rest of industries can be found in the annex 2, and reinforces the idea about the different patterns of clustering of each creative industry, even if some regularities (for example the relevance of the largest metropolitan areas) can be observed.

The fourth question is ***which are and where are located the largest clusters***? The largest clusters are located in the central part of the largest European cities (Figure 7). If we consider for simplicity those clusters of more than 1,000 firms, Paris and London host 11 large clusters each one; Madrid and Stockholm host 5 large clusters; Berlin, Brussels, Lisbon and Munich host 3 large clusters; Barcelona, Helsinki, Milan and Roma host two large clusters; and Copenhagen and Goteborg host 1 large cluster each one. The only large cluster none located in a LUZ is the fashion cluster of Guimaraes in the north of Portugal[8].

[8] The details are in the annexes.

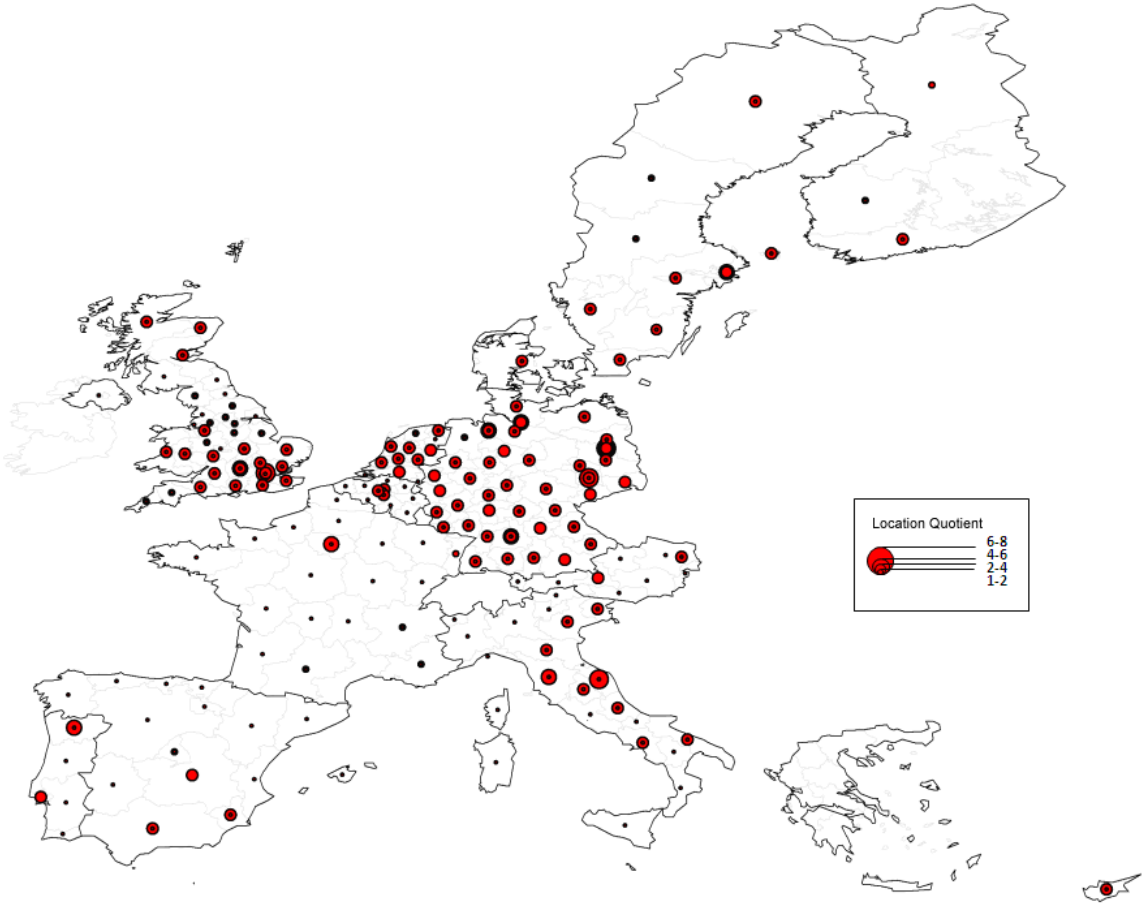
In addition, these large clusters tend to be surrounded by other clusters of the same creative industry, as well as by clusters of other creative industries (Figure 6). Thus, creative cities are made of a great number of creative clusters overlapped, which, according to the Figures 3 and 7, nourish with a complex range of localization economies and related variety externalities internal to the cluster, as well as other external economies coming from synergic and complementary networks between neighbour clusters.

Figure 3. Creative clusters in Europe. Microdata clusters overlapped. Amadeus data. Dot map



Source: Elaborated from Amadeus.

Figure 4. Creative clusters in Europe. Location quotients by industry and region overlapped. Eurostat data. Dot map



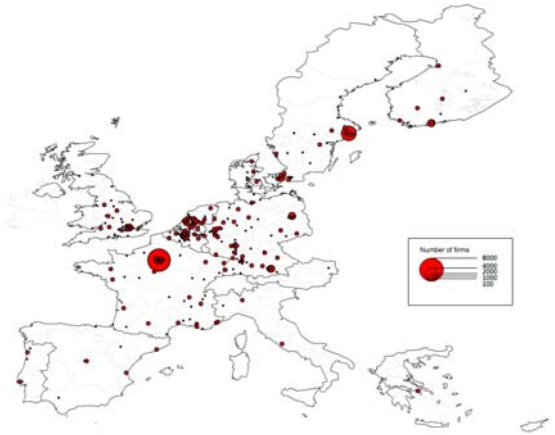
Source: Elaborated from Eurostat SBS.

Figure 5. A comparison between the NNHC with geo-referenced microdata and the LQ using Eurostat regional data for two industries

NNHC with microdata *LQ by region*

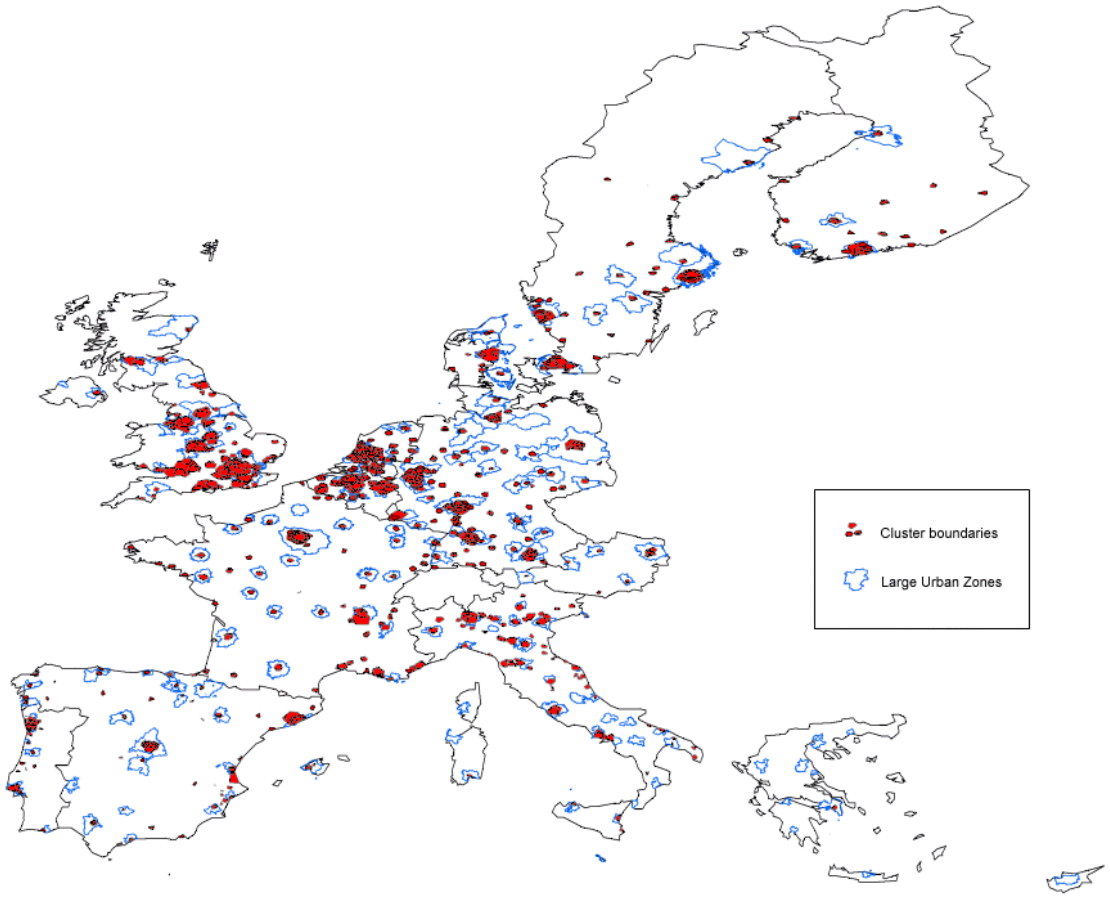
A) Fashion

B) Software



Source: Elaborated from Amadeus and Eurostat SBS.

Figure 6. Creative clusters and Large Urban Zones. Clusters overlapped. Hulls map



Source: Elaborated from Amadeus and Urban Audit.

Figure 7. Detail of four types of clusters in London and Paris. Scale 1:1250000

London Paris

Architecture

Fashion

Film, video and music

Publishing

Source: Elaborated from Amadeus (Bureau van Dijk).

5. CONCLUSIONS

This research has its origins in the necessity to improve the empirical evidence about the localization of the clusters of creative industries in Europe. The research is the first study of this type we know for the European Union in the ambit of clusters covers an important gap the scientific literature and as an ancillary instrument for the elaboration of policy strategies.

The results validate the feasibility to use this kind of methodologies based on microdata and geostatistics to identify clusters in Europe and open new ways to other similar researches. The results we obtained are much rich and detailed than other obtained with usual methodologies, and they allows for the study of clusters in a range that goes from the regional level to the internal detail in metropolitan areas and cities. They provide a powerful tool that allows to design strategies in several levels, in an independent or complementary way.

The main conclusions we obtained are:

First, there are a large number of clusters of creative industries in Europe (1,784 for the 16 countries and 15 industries we studied) and about 61% of the creative firms are located in these clusters. Thus, in most of the places the priority wouldn't be the generation of clusters of creative firms but the articulation of policy strategies encompassing those clusters that already exist.

Second, the clusters of creative industries are distributed across all the European territory. Each city, local production system or region specializes in concrete clusters and owns particular combinations of these clusters. Thus, the distribution of these clusters and their diversity suggest to advance towards strategies to support the clusters and the linkages between the different clusters. The objective is not only to take advantage from specialization but also from the cross-linkages between clusters and the related varieties when the clusters share the same geographical and relational space. Furthermore, the existence of bunches of neighbour or close clusters suggest to develop strategies based on networks of synergy and complementariety between clusters.

Third, the clusters of creative industries tend to concentrate in the metropolitan areas (large urban zones) and are particularly important in the largest ones, even if we found some clusters outside of the metropolitan areas, as well as metropolitan areas without any significant cluster. Furthermore, inside the cities, the clusters of creative industries reveal a preference for the central locations due to the fact that they make use of a wide range of externalities generated in these spaces. These patterns of spatial location suggest that it is possible to take advantage from the combination of policy strategies from several levels: top-down plus bottom-up or sectoral plus spatial.

Finally, the methodology has some limitations where the most important is the use of horizontal chains although it is possible to substitute the final industry by previously defined productive chains. Thus, one of the ways to enrich the results will be the incorporation of vertical chains.

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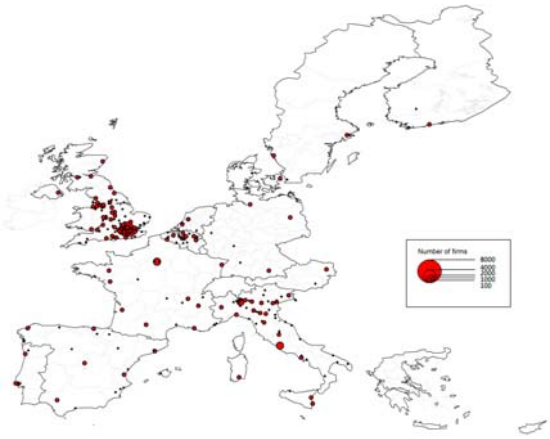
Annex 1. Largest clusters in Europe. Clusters of more than 1,000 firms.

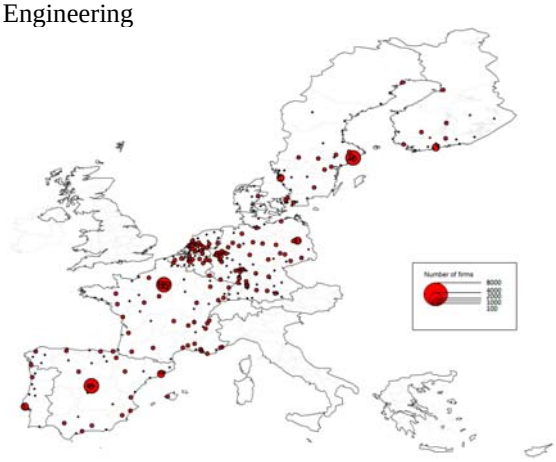
Industry	Cluster	Firms
Advertising	Paris	3,753
Advertising	Madrid	2,448
Advertising	London	2,294
Advertising	Barcelona	1,465
Advertising	Stockholm	1,411
Advertising	Brussels	1,258
Advertising	Milan	1,167
Architecture	London (1)	7,435
Architecture	London (2)	3,909
Architecture	Lisbon (2)	1,271
Architecture	Brussels	1,143
Architecture	London (3)	1,133
Architecture	Lisbon (2)	1,112
Cultural trade	Paris	7,760
Cultural trade	London	4,534
Cultural trade	Roma	1,324
Cultural trade	Madrid	1,261
Cultural trade	Stockholm	1,215
Cultural trade	Munich	1,210
Cultural trade	Berlin	1,051
Engineering	Paris	3,575
Engineering	Madrid	2,244
Engineering	Stockholm	2,049
Engineering	Berlin	1,283
Engineering	Barcelona	1,190
Engineering	Helsinki	1,076
Engineering	Lisbon	1,062
Engineering	Goteborg	1,027
Fashion	Paris	1,782
Fashion	Guimaraes	1,264
Film, video and music	Paris	7,435
Film, video and music	London	3,909
Film, video and music	Roma	1,271
Film, video and music	Madrid	1,143
Film, video and music	Stockholm	1,133
Film, video and music	Munich	1,112
Performing arts	London	5,242
Performing arts	Paris	2,018
Photography	London	1,420
Publishing	Paris	3,156
Publishing	London	2,375
Publishing	Madrid	1,154
Radio and TV	Paris	2,247
Software	Paris	6,696
Software	Stockholm	3,201
Software	Brussels	1,662
Software	Helsinki	1,653
Software	Copenhagen	1,608
Software	Munich	1,467
Software	Berlin	1,090
Software	London	1,001
Videogames	Paris	1,969
Videogames	Milan	1,662
Videogames	London	1,567

Annex 2. Clusters by creative industry

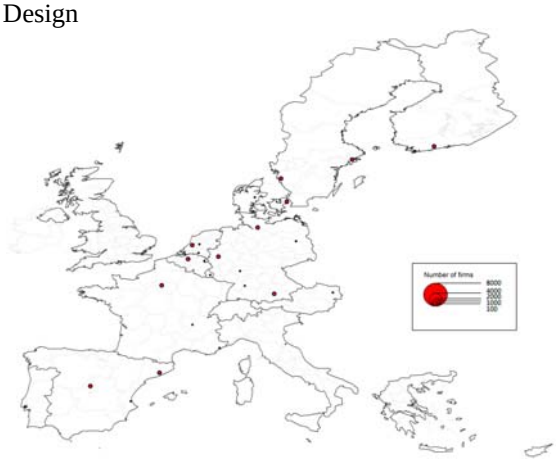
Architecture



Engineering



Design



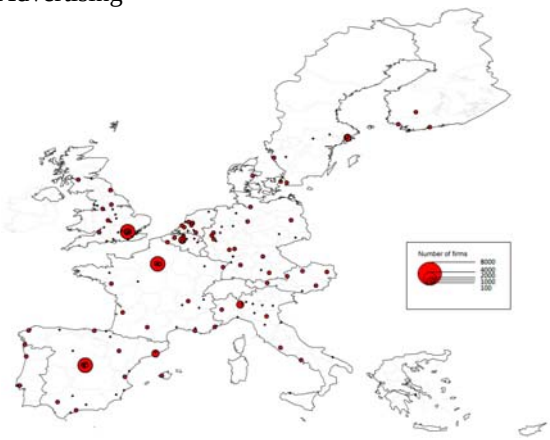
Fashion

Broadcasting (radio and TV)

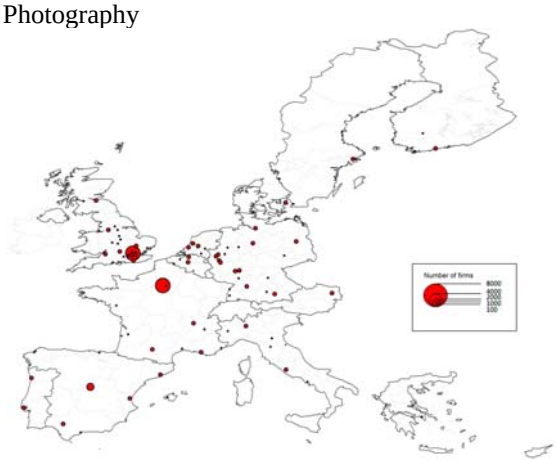
Film, video and music

Publishing

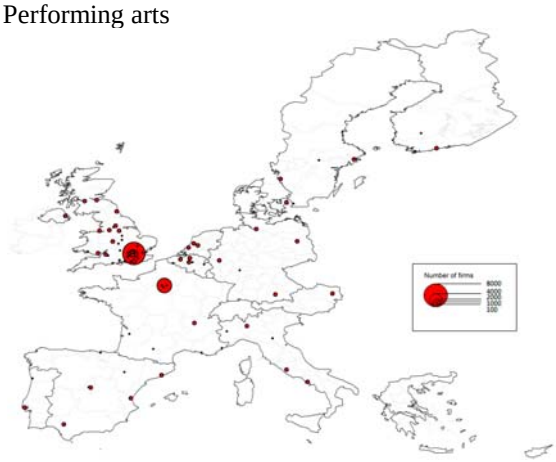
Advertising



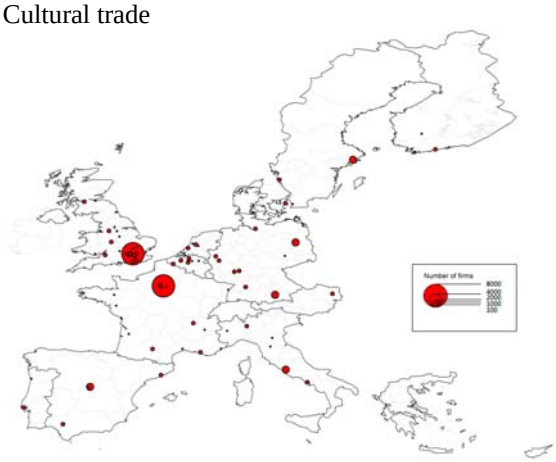
Photography



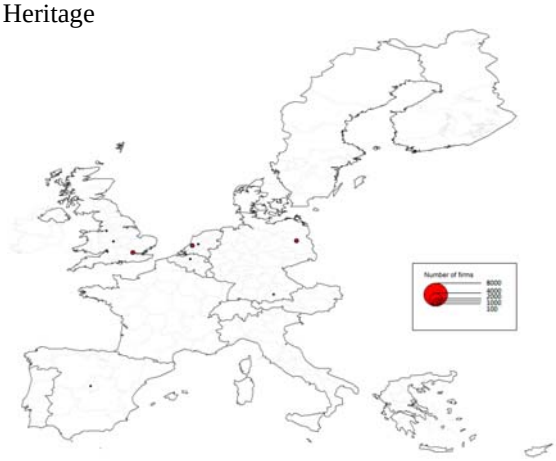
Performing arts



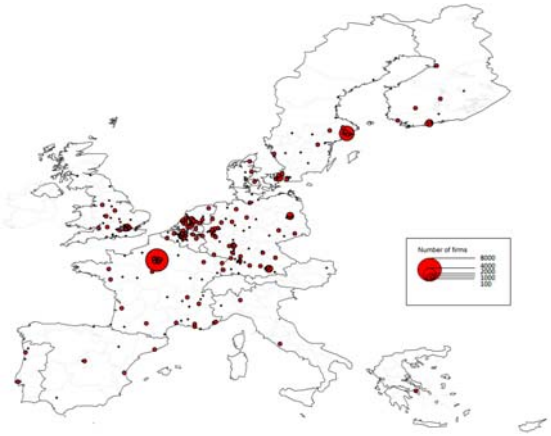
Cultural trade



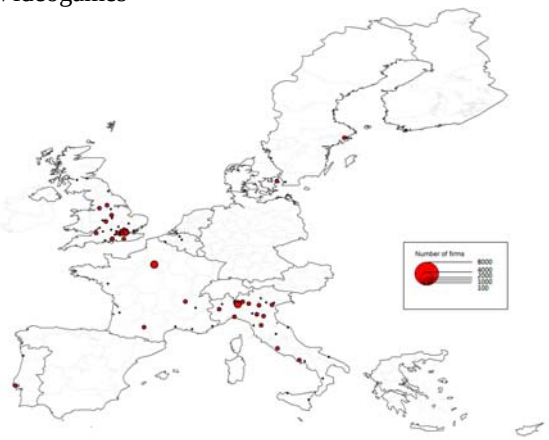
Heritage



Software



Videogames



Research and development