# SPATIAL DISTRIBUTION OF CREATIVE SECTORS: EVIDENCE FROM THE METROPOLITAN CITY OF ROME

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**ABSTRACT**

The purpose of this paper is to analyse the location patterns of creative sectors in the Metropolitan City of Rome. The spatial distribution of firms is studied by utilising spatially referenced point data as input to a statistical model based on Ripley's *K*-function. Pairwise differences between *K*-functions of observed point patterns are computed and compared with simulated confidence bands. A null hypothesis of random labelling is tested upon two conditions: by analysing the spatial distribution of different creative sectors with respect to the rest of creative activities and by comparing, for each creative category, localization patterns of core creative firms with respect to the localization of respective service functions. The empirical analysis showed that creative sectors have highly different spatial behaviours, depending on their characteristics and their level of interaction with the urban *milieu*. In general, core creative activities in have the tendency to cluster in space at small distances (up to 20 – 40 kilometres) while the respective service sectors are dispersed internally and disposed around the core.

Key words: creative industries, spatial patterns, *K*-function, spatial statistics.

J.E.L. Classification: C40; R12

## 1 Introduction

The interest towards the spatial analysis of economic issues has grown since the publication in 1991 of *Geography and Trade*, by Paul Krugman. By proving the incentive to migrate towards urban areas, both for firms and individuals, the core-periphery model proposed by Krugman, launched the so-called 'new economic geography', contributing to its integration with mainstream economics (Fujita and Krugman, 1995; Fujita, Krugman and Venables, 1999; Fujita, Krugman and Mori, 1999). In this context, it has become clear that the study of spatial concentration of economic activities can shed light on economic theoretic hypotheses concerning the nature of increasing returns and the determinants of agglomeration (Glaeser and Maré, 2001; Eaton and Eckstein, 1997; Peri, 1998; Black and Henderson, 1999; Charlot and Duranton, 2004; Rosenthal and Strange, 2008). There is extensive evidence in literature about the fact that spatial concentration of firms in urban areas determines their access to a more extensive and specialised labour pool. Moreover, firms gain access to a greater range and quality of shared inputs and supporting services and take advantage from the 'knowledge spillovers' that help to disseminate good practice and facilitate new products and processes (Lash and Urry, 1994; Scott, 2001; Duranton and Puga, 2005; Van Widen et al., 2007).

Statistical techniques for modelling geographic concentration of economic activities both on a discrete space and on a continuous space are relatively recent. According to Anselin (2006), it is possible to distinguish between two empirical approaches to spatial analysis: spatial econometrics and spatial statistics: the first approach is concerned with the introduction of spatial effects in regression analysis (Anselin, 1988); the second one refers to statistical models enabling for the analysis of spatially referenced data (Ripley, 1981). This latest research brunch focuses on characterizing the spatial distribution of economic activities with respect to a set of hypotheses.

Different measures of spatial concentration have been developed in literature. A first group derives from the Gini coefficient that introduced distribution inequalities (Gini, 1912). Space played no role in these measures, in the sense that they do not rely on any discretization scheme (e.g. Kurgman, 1991). Space is taken into account in aggregated indexes of spatial concentration, such as the Hirschman-Herfindhal index (HHI), or the Ellison and Glaeser index (EG); the latest is a measure that takes into account space and controls for the underlying industrial concentration (Ellison and Glaeser, 1997). The most widely used measure for spatial concentration of economic activities is perhaps the location quotient (LQ) coined by Porter in 1990. LQ was the expedient for introducing the concept of industrial clusters at the basis of economic development policies, both in international and national levels.

Drawbacks of spatial concentration measures have been widely discussed in scientific literature. For example, Martin and Sunley (2003) argued that, when using location quotients, we look at measures of regional specialization, not at clusters. Feser (2000) found that in applied work the EG index is sensitive to the level of spatial aggregation. Spatial aggregation is indeed a bone of content amongst spatial statisticians. The above-mentioned measures of spatial concentration use data aggregated according to pre-defined spatial units: space, which is naturally continuous, is thus subjected to representation models, which rely substantially on administrative subdivisions at various geographical scales. This problem is known in the statistical literature as the Modifiable Areal Unit Problem (Gehlke and Biehl, 1934; Yule and Kendall, 1950; Openshaw, 1984; Arbia, 1989; Cressie, 1993). The

modifiable areal unit problem (MAUP) is a source of statistical bias that can radically affect the results of statistical hypothesis tests, since subdividing a continuous space in a set of discrete spatial units leads to spurious correlations across aggregated variables (Duranton and Overman, 2005; Combes et al., 2008; Briant et al., 2010). These effects can be overcome by using a continuous approach to space, where data are collected at the maximum level of spatial disaggregation, i.e. each industry is identified by its geographic coordinate (x, y), and spatial concentration is detected by referring to the distribution of distances amongst observations. Theoretical aspects of distance-based spatial concentration measures are discussed in detail in many publications (Ripley, 1976; 1977; Diggle, 1983; Cressie, 1993; Stoyan and Stoyan, 1995; Upton and Fingleton, 1985; Baddeley et al., 2000).

Unlike other fields, such as ecology or epidemiology, distance-based methods are rather new in economics (Barff, 1987; Sweeney and Feser, 1998). Duranton and Overman (2005) provide exhaustive account of the advantages deriving from the use of these methods in economic studies. The localization processes of industries can be analysed in terms of different forms of spatial association (Arbia et. al., 2008) or relative concentration (Duranton and Overman, 2005; Marcon and Puech, 2010; Espa et al., 2010a; Jacobs et al., 2013), by means of univariate, bivariate or multivariate generalizations used to describe relationships between point patterns.

Creative industries are considered a propulsive force in the context of knowledge-based global economy (Pratt, 2012). They represent one of the most dynamic sectors in advanced economies and have played a major role in economic regeneration of previously deindustrialised local economies. Creative industries include: the media (e.g. films, television, music recording, publishing); fashionable consumer goods sectors (e.g. clothing, furniture, jewellery); services (e.g. advertising, tourism, entertainment); a wide range of creative professions (e.g. architecture, graphic arts, web-page design); and collective cultural consumption facilities (e.g. museums, art galleries, concert halls). They are characterised by the blurring of the symbolic and utilitarian functions of the products and by the strong tendency to cluster in large and dense urban areas (Scott, 2010).

The influence of creative industries in economic development is generally studied according to two main research lines: spatial aggregation of creative firms and their determinants (Scott, 2006; Lazzeretti et. al., 2012; Marrocu and Paci, 2012; De Miguel Molina et al., 2012); influence of creative people in employment growth (Florida, 2002; 2004; Scott, 2010). The analysis of localization of creative firms is very recent (Boix et al., 2012), as studies of this kind so far have privileged the manufacturing sector. The scarcity of detailed studies on location patterns of creative industries is, to a certain extent, arguable in the light of the difficulties to provide a clear definition of the creative sector (Garnham, 2005; Evans, 2009; Scott, 2010; Flew, 2010) and of fact that creative activities are in part invisible to data collection (Girard, 1982). If we consider also the difficulty to produce (and to obtain) disaggregated data on economic activities in general and on the creative sectors in particular, we can figure out why point-pattern analysis has not yet been applied to this economic sector.

The use of distance-based statistical methods to analyse the location patterns of creative industries appears however a promising research field. Indeed, a closer look on the creative clusters, their physical extension and their components, would facilitate interpretation and give precious insights of the types of relationships that take place within these complex spatial arrangements.

Geographic concentration of creative firms increases the opportunities for them to interrelate, to employ suitable labour, to benefit from common infrastructure and to reduce market uncertainties. Spatial extension and density of economic activities determine the significance of these benefits. In the context of creative industries, a major challenge would be to test for spatial concentration of firms in the different creative subcategories. Much it has been written about economic activities that should or should not be part of the creative domain (software; advertising; heritage): the study of spatial interactions between creative categories within specific geographical areas, would be a good exercise for identifying and interpreting mutual relationships, and a way of compensating for the arbitrary nature of many definitions. Moreover, testing for co-localization of creative subcategories, would offer indirect evidence of the impact of urbanization economies in clustering of creative industries. It has been widely argued that production chains affect industrial clustering (Turok, 2003). Firms within production chains tend to locate close together to minimize the costs of communication. Good internal and external transport infrastructure and logistics systems are important for the competitiveness of industrial complexes. In the case of creative industries, testing for co-localization between content-creation creative activities and 'support' activities, such as the production and distribution of complementary outputs, would offer direct evidence on the spatial relationships that creative industries hold with the rest of the creative value chain.

We study the spatial distribution of creative industries in the Metropolitan region of Rome utilising spatially referenced point data as input to a statistical model based on Ripley's *K*-function. We compute pairwise differences between *K*-functions of observed point patterns and compare them with simulated confidence bands. We test a null hypothesis of random labelling upon two conditions: by analysing the spatial distribution of different creative sectors with respect to the rest of creative activities and by comparing, for each creative subcategory, localization patterns of creative firms with respect to the localization of respective service functions. The analysis aims to answer at the following research questions:

Are creative categories spatially concentrated?

Which are the spatial relationships between the creative activities and the 'support' activities?

The rest of the paper is organized as follows. Section 2 provides a literature review on spatial clusters and creative industries. Section 3 gives some insight on point pattern analysis and spatial cluster modelling. Section 4 provides a descriptive analysis of the creative industries in the study area. Section 5 presents the results of the empirical analysis. Section 6 summarizes the main findings and conclusions.

## 2 Literature review

### *2.1 Clusters*

The cluster concept has proven to be attractive so that literature on cluster definitions and cluster benefits has proliferated over the last decades (Scott, 1988; Camagni, 1991; Jacobs and De Jong, 1992; Doeringer and Terkla, 1995; Jacobs and De Man, 1996; Powell,

1996; Feser, 1998; Steiner, 1998; Bergman and Feser, 2000; Maskell and Mamberg, 1999; Bellandi, 2006; Gordon and McCann, 2000; Bathelet et al., 2004; Iammarino and McCann, 2006; Jacobs et al., 2013; Molina-Morales, 2013).

Clusters became an economic development paradigm in regional economic policy, thanks to the work of Porter (1990; 1996; 1998) that promoted the role of industrial clusters in raising regional productivity and innovative capacity. Porter's research, mostly derived by case studies, pointed out the fact that clusters can act as a centripetal force, able to contrast the centrifugal forces of contemporary globalization processes (dispersion of firm activity through outsourcing and offshoring). Thus, clusters encourage local competition and new business formation, contributing to the integration of firms in the local economy (Woodward and Guimaraes, 2009).

Despite broad success of the cluster concept in various policy-making levels, the cluster approach is frequently criticised in academic literature. A general 'disturbing' aspect is related to the confusion/lack of clarity in the basic terminology of clusters, but criticism embraces also methodological aspects. Martin and Sunley (2003) remark that the vagueness/fuzziness of Porter's 'neo-Marshallian' cluster concept does not lend to easy or precise delineation, with the consequence 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'*. Woodward and Guimaraes (2009) admit that, on Porter's definition, clusters are hard to identify and track over time. Malmberg and Power (2005), point at the fact that there is little evidence of the effects of clustering and *'…the evidence that does exist does not seem to show what we want them to show…'*. Glasmeier (2000) argues that the benefits realized from geographical clustering appear to be specific to certain industries at certain stages of development in certain places, and are only realized under particular conditions. Writing about regional advantage and platform policies, Asheim, Boschma and Cooke (2011), bring evidence about the cluster perspective looking (already) an '*old fashioned*' policy model for platform technologies such as software, displaying pervasive characteristics and complex interactions that are beyond conventional sectorial-spatial notions such as clusters.

Conceptual and methodological issues on cluster definition are further affected by the long-running controversy between supporters of 'Marshall' and 'Jacobs' economies that is far from being resolved (Beaudry and Schiffauerova, 2009). The debate is on whether agglomeration economies or urbanization economies are more important and beneficial (Glaeser et al., 1992; Henderson et al., 1995; Feldman, 2000; Audrechst and Feldman, 1996). Recently, a new stream of research presents a more nuanced view of the benefits brought by 'specialisation' and 'diversity'. Proponents of the 'related variety' concept have argued that beneficial externalities are more important in geographical areas where diverse sectors are able to develop intense relationships. Variety is a source of competitive advantage for the firms located in a place, but only if the diverse sectors that are located together have complementary capabilities and resources. In these cases, 'knowledge spillovers' take place around a 'theme', rather than around a sector (Asheim et al., 2007; Boschma and Iammarino, 2009).

Indeed, cluster definition is a complex task, strongly related to the identification of the causes of concentration. Gordon and McCann (2000) distinguish three stylized forms of spatial clustering, depending on the dominant or characteristic process occurring 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.

There seems to be a gap between theoretical teachings (and controversies) and mapping clusters exercises: most of the studies on cluster mappings have focused on a particular industry, or involved methodologies in which an industry has been selected as representative of a place (e.g. Becattini et al. 2009), while issues such as the spatial patterns of location and co-location of clusters sharing the same geographical space, are some of the most neglected aspects in cluster literature. This is probably due to the fact that 'cluster is a spatial concept in which a-spatial processes play a prominent role' (Boschma and Klosterman, 2005). Simplifications highlight the true difficulty of dealing with the geographical/functional complexity of cluster components, widely recognized by cluster theorists.

Another striking problem is scale. May studies choose to deal with large-scale geographical units, such as states or regions, making the assumption that sectorial employment values for these units provide a direct measure of the strength of cluster development. Martin and Sunley (2003) explain that '*… extensive methodologies of top-down mapping exercises can at best only suggest the existence and location of possible clusters: they provide a shallow, indirect view of clusters. They cannot provide much about the nature and strength of local inter-firm linkages, knowledge spillovers, social networks and institutional support structures, argued to be the defining and distinctive features of clusters*'. As cluster analysis is rooted in regional studies, urban clusters are an isolated and rather scarce branch of research. At present, the feasibility of work with detailed data on single firm location and activity, offers interesting research opportunities in this field.

*2.2 Creative clusters*

Despite criticisms and controversies characterizing the cluster concept, it is widely accepted that creative industries show a clear tendency to concentrate in dense urban environments, typically, metropolitan areas. In distinction from manufacturing clusters, the relevant factors for explaining the clustering of creative industries (i.e. services with a symbolic knowledge base) are not only the benefits of localization (and specialization) economies, but also, in great part, the effects of old and new types of urbanization economies (Mommaas, 2004; Cooke and Lazzeretti, 2008; De Propris et al., 2009; Lazzeretti et al., 2012). Urbanization economies typically produce location patterns of cluster overlapping. Co-location provides cross-fertilization urbanization economies (Jacobs, 1969; 1984; Lorenzen and Frederiksen, 2008), opportunities for the co-presence of related variety (Boschma and Frenken, 2011), buzz (Storper and Venables, 2004), and access to collective learning and shared knowledge resources (Keeble and Nachum, 2002).

Localization patterns can be monocentric or polycentric, according to the city size and functional characteristics. Typically, large cities, with sensible land rents variation are characterized by polycentric distribution of activities and functions. In these conditions clusters of the same activity can be found in different parts of the city, partially overlapping with clusters of other activities and taking the form of clouds of clusters. Such patterns cannot be observed through a macro-scale perspective, for this reason, the micro-scale analysis becomes indispensable to capture specific cluster characteristics (Boix et al., 2012).

De Propris and Hypponen (2008) defines a creative cluster as a place that brings together: a) a community of 'creative people' who share an interest in novelty but not necessarily in the same subject; b) a catalysing place where people, relationships, ideas and talents can spark each other; c) an environment that offers diversity, stimuli and freedom of expression; and finally d) a thick, open and ever changing network of inter-personal exchanges that nurture individuals' uniqueness and identity.

Britain's Department of Culture Media and Sports (DCMS), following its seminal (and highly discussed) approach on creative industries, defines creative clusters as '*groups of competing and co-operating businesses that enhance demand for specialist labour and supply networks in a particular location. Such infrastructure depends not only upon the vitality of the creative sector itself, it is also underpinned by public policy and significant public investment*' (DCMS, 2006).

There is a consistent number of studies on creative places, highlighting the different aspects of geographical concentration of creative activities and creative people, and the mechanisms through creative industries generate externalities (agglomeration and urbanisation economies) and improve the creative potential of the places where they are located (Roodhouse, 2006; Florida, 2002; 2004; Momaas, 2004; O'Connor, 2004; Pratt, 2004; 2007; 2011; Scott, 2010). These studies support the existence of specificities and complementarities between creative sectors that influence their clustering patterns. The majority of studies on creative clusters have looked inside the structure of sector-specific creative activities, analysing the relationships between firms, the drivers of new firm start-ups and the role of government intervention. For example, Kebir and Crevoisier (2008) argue that the Swiss watch-making cluster defines the cultural identity of the place and its community and is an economic resource for the regional economic development. Belussi and Sedita (2008) analysing the performing music cluster of Verona, maintain that opera performances are collective cultural goods whose production requires the integration of complementary resources in form of 'networks of activities' that require geographical proximity to support 'the creativity of artistic performers'. Wenting (2008) studied the development of the fashion designer cluster in Paris, finding that it was driven by the emergence of start-ups and knowledge spillovers between firms. In their analysis of five creative sectors in New York and Los Angeles, Currid and Williams (2006) showed that the tendency of certain creative firms to locate close to each other is a function of specific infrastructural requirements in infrastructures. Studies on Hollywood film cluster (Scott, 2002; Coe, 2001; De Propris and Hypponen, 2008) have described a hybrid cluster with strong local agglomeration economies and powerful global connections.

Research on creative clusters includes, in addition, case studies on the Scottish film cluster (Turok, 2003), the film industry cluster in Potsdam (Kratke, 2002), the Cologne media cluster (Mossig, 2004), the Liepzig media cluster (Bathelt, 2002), the Montreal multimedia cluster (Tremblay and Rousseau, 2006), the clustering of the media industries in London (Pratt, 2012). There are also studies that have looked into the international dimensions of creative places in the music industry (Power and Hallencreutz, 2007) and in the media industry (Nachum and Keeble, 2003), showing how urban creative clusters balance their local relationships with wider links that go beyond geographical limits. The richness in case-specific studies does not compensate for the lack of solid analytical bases on affronting creative cluster issues (Boix et al. 2012), as well as for the little influence of micro-oriented analytical approach (Fagerberg, 2006). Creativity and its specific forms of expression in urban areas can be effectively analysed at the maximum level of spatial

disaggregation, identifying each industry by its geographic coordinate, and by and detecting spatial relationships through statistical models that refer to distance-based concentration measures.

## 3 Point-patterns and spatial cluster modelling

Measures that treat space as continuous can overcome discretization problems (Feser and Sweeney, 2002; Duranton and Overman, 2005; 2008; Marcon and Puech, 2010), provided that detailed information on localization patterns of phenomena exists. Point pattern analysis is a group of statistical techniques that aim to identify patterns in spatial data. Spatial point patterns are formalized as: univariate, bivariate, inhomogeneous, marked or space-time patterns. Paradigmatic examples of spatial point patters are: a) aggregated pattern, b) regular pattern, c) random pattern (Schabenberger and Gotway, 2005).

In the spatial domain, it is possible to view an aggregated pattern in different ways depending on the focus of the analysis. Generally, aggregations are considered as originated by random effects, which are governed by global model parameters, controlling for the scale and frequency of aggregations. This is similar to the geostatistical view of random processes, where the intensity or local density of events is defined by some type of spatial process. The peaks of this process would correspond with local aggregations. Examples of this approach can be found in Cressie (1993) and Diggle et al. (1983). Point processes based in inferential methods involve comparisons between empirical summary measures and theoretical summary measures of an underlying point process. The basic probabilistic assumptions are stationarity and isotropy: stationarity implies that all properties of the process are invariant under translation; isotropy implies that all properties of the process are invariant under rotation.

The null hypothesis to be tested is the one of Complete Spatial Randomness (CSR) that implies (i) constant propensity to host points (uniformity) and (ii) absence of spatial interactions amongst points; i.e. each point's location is independent from the other points' locations (independence).

The homogeneous Poisson process represents an idealized standard of the hypothesis of CSR: (i) for any constant point intensity $\lambda$, the number of points located in an area $A$, follows a Poisson distribution with mean $\lambda |A|$; (ii) the $n$ points in $A$ constitute an independent random sample from the uniform distribution on $A$. Observed pattern distributions that deviate from complete spatial randomness hypothesis include aggregated patterns or inhibitory patterns. Under the null hypothesis of CSR, second order properties can be described by the function introduced by Ripley (1976; 1977), and named Ripley's $K$-function.

$$\lambda K(d) = \mathrm{E}[\#\text{of points with distance} \leq d | \text{at x}] \tag{1}$$

where:
$\lambda$ is the intensity of the point process;
$K(\,)$ is an interpoint distance distribution function: $K(d) \to \infty$ as $d \to \infty$.

Ripley (1988) suggests a simple estimator for $K(\ )$ in (1), that accounts for edge effects correction:

$$\widehat{K}_o(d) = \frac{1}{\lambda n}\sum_{1}^{n} \#\ (\text{other points within distance } d \text{ of } x_i\ ) \tag{2}$$

where $n$ is the number of points in the area with radius $d$.

Bivariate $K$ functions are based on the Ripley's $K$-function but refer to two different sets of points (for instance, type $i$ and Type $j$). Thus, a bivariate $K$ function is defined as the expected number of type $i$ points falling at a distance ≤ d from an arbitrary type $j$ point. The most widely used estimator for bivariate $K$ function is by Lotwick and Silverman (1982), which is also implemented in SPlancs package in R.

The application of statistical methods based on bivariate point patterns for the study of economic activities allows unveiling co–agglomeration and/or repulsion tendencies amongst pairs of industrial activities. Null hypothesis specification for bivariate patterns in economic applications is rather complex. This is due to the fact that localization processes of two different industries may be influenced by exogenous factors, as well as by mutual relationships between firms. Arbia et al. (2008) suggest two possible definitions of null hypothesis, depending on the study object and characteristics: a null hypothesis of *independence* and a null hypothesis of *random labelling*.

Under the hypothesis of *independence,* it is assumed that type $i$ and type $j$ point patterns are generated, respectively, by two different and independent univariate point processes. The absence of interaction between them is to be interpreted as lack of interaction between the two generating fields (Lotwick and Silverman, 1982). Under this hypothesis, $H_0: K_{ij}(d) = \pi d^2$. Agglomeration is observed when inside a circle with radius $d$ centred on an arbitrary type $i$ point, the number of type $j$ points is higher than expected under the $H_0$, then, $K_{ij}(d) > \pi d^2$. On the contrary, inhibition takes place when $K_{ij}(d) < \pi d^2$. To verify whether observed distribution of firms differs from random distribution, confidence intervals are generated by simulating a large number of independent distributions generated by Monte Carlo simulations (Besag and Diggle, 1977).

Under the hypothesis of *random labelling* a firm can belong randomly to type $i$ or type $j$. In the case of economic activities, this can be interpreted as the existence of conditions that encourage location of one industry rather than the other. Under this hypothesis: $H_0: K_{ij}(d) = K_{ji}(d) = K(d)$ (Diggle and Chetwynd, 1991).

The null hypothesis of *random labelling* is evaluated by computing the pairwise differences between the various $K$ functions and by comparing them with simulated confidence bands (Diggle and Chetwynd, 1991; Gatrell et al., 1996; Kulldorff, 1998; Dixon, 2002; Haining, 2003). Agglomeration is observed when $K_{ij}(d) = K_i(d) - K_j(d) > K(d)$, inhibition is observed when $K_{ij}(d) = K_i(d) - K_j(d) < K(d)$. Confidence intervals are generated using Monte Carlo simulations, by keeping firm's location unchanged and by randomly assigning the labels that characterize each sector.

Over the last decade exhaustive account it was given about the advantages deriving from the use of distance-based methods in economic studies. Notwithstanding, empirical applications are still limited (Arbia and Espa, 1996; Duranton and Overman, 2005; 2008; Marcon and Puech, 2003; 2010; Quah and Simpson, 2003; Arbia et al., 2008; Espa et al., 2010a; Jacobs et al., 2013). Bivariate *K*-function is the most widely used method amongst the economic applications of point-pattern analysis, because it enables for rather straightforward testing procedure for spatial association between pairs of sectors. There are also other empirical examples of the application of *K*-functions for mark-weighted patterns (Espa et al., 2010b) and space-time patterns (Arbia et al., 2010).

## 4 Creative industries in the metropolitan region of Rome: descriptive analysis

The Metropolitan City of Rome[1], located in central Italy, covers an area of 5352 km$^2$ and has 121 *comuni* (municipalities). The area is dominated by the presence of the city of Rome and its strongly concentric metropolitan system that accounts for almost 7% of the total Italian population. According to the last census, the provincial population amounts at 3.997.465 inhabitants, of whom 65% live in the municipality of Rome, 25% in first belt municipalities and 10% in peripheral ones.

The data used to analyse the creative industry in the study area are from The Statistical Archive of Local Units of Active Enterprises (Archivio Statistico delle Unità Locali delle Imprese Attive: ASIA-UL), provided by the National Institute of Statistics. This is a business register annually updated through a process of integration of administrative and statistical sources. ASIA-UL is constituted by economic units exercising trades and professions in industrial commercial and services activities. It provides identification information (name and address) and information about the structure (economic activity, dependent and independent workers, legal form, turnover) of such units. The data concern the accurate location in space of each firm (firm coordinates), the economic activity (5 digit ATECO code) and the number of employees of local units dependent on the main enterprise, being active for at least six months during the reference year. The data utilized refer to the study area in the year 2007. Principal problems when using the ASIA-UL dataset concern the varying localization accuracy (about 1.5% of the firms is located on the centroid of the municipality of reference; about 0.6% is located on the centroid of the postal code area), and the absence of firm demography.

The definition of creative categories is the one proposed in the 'Geography the creative industries' by DCMS, that uses 5 digit SIC codes (De Propris et al., 2009), adapted for the Italian ATECO categories. According to this definition, for every creative sector activities are classified in 'layers', which can be interpreted as stages in a creative value chain. Content creation is located at the 'core' and other functions such as distribution and production of complementary outputs lay in the 'periphery' of the classification system. Layer one includes more intrinsically creative activities at the top of each supply chain (for example, composition for the music industry, programming for the computer games industry and writing for the publishing industry). Layer two includes those activities that directly support layer one activities in the supply chain (for example, casting for the performing arts). Layer three includes the manufacture of the hardware that directly supports the

[1] Territorial limits of the Province of Rome formally coincide with those of the Metropolitan City of Rome, established as an administrative body since January 1st 2014.

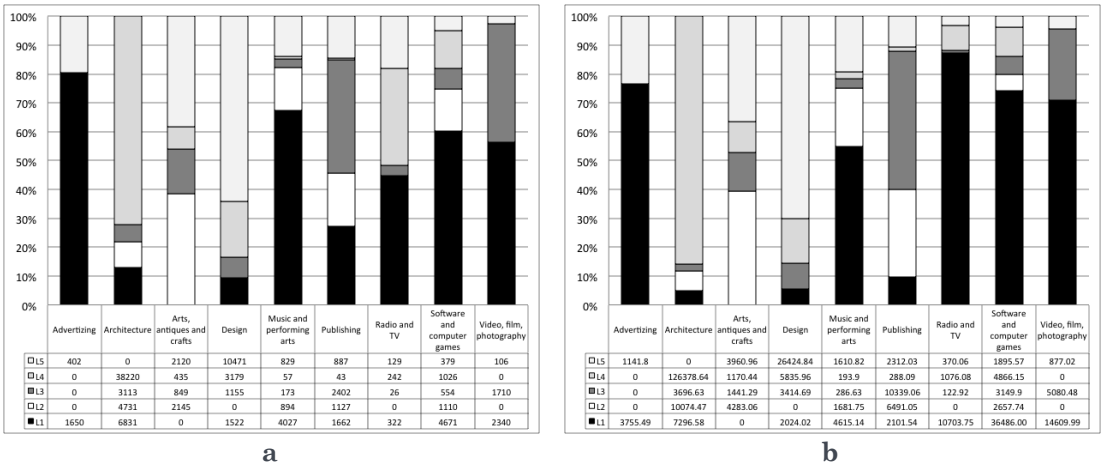
creative process (for example, the manufacture of television cameras and other hardware directly used in creating television programmes). Layer four includes the manufacture and wholesale of raw materials and the manufacture of hardware used in the consumption of creative industry products (for example, arcade machines for computer games). Layer five includes the sales of creative products (for example the sale of games consoles for the computer games industry).

The number of firms and employees for each core creative category (Layer1 and Layer 2) in the year of observation 2007 and their respective weight in each value chain are reported in Table 1. Figure 1 illustrates the distribution of firms (a) and employees (b), according to the different position they hold within the value chain of each creative category. Detailed distribution of firms and employees in each layer is reported in Appendix 1.

**Table 1.** Core creative industries (layer 1 and layer 2) in year 2007, according to the DCMS classification.

| | N. firms | N. employees | % firms | % employees |
|---|---|---|---|---|
| Advertising | 2052 | 4897.29 | 100 | 100 |
| Architecture | 11562 | 17371.05 | 22 | 12 |
| Arts, antiques and crafts activities | 4108 | 7926.79 | 76 | 75 |
| Design | 1522 | 2024.02 | 9 | 5 |
| Music and performing arts | 4921 | 6296.89 | 80 | 72 |
| Publishing | 2789 | 8592.59 | 46 | 40 |
| Radio and TV | 322 | 10703.75 | 45 | 87 |
| Software and computer games | 5781 | 39143.74 | 75 | 80 |
| Video, film and photography | 2340 | 14609.99 | 56 | 71 |

Source: ASIA-UL 2007.

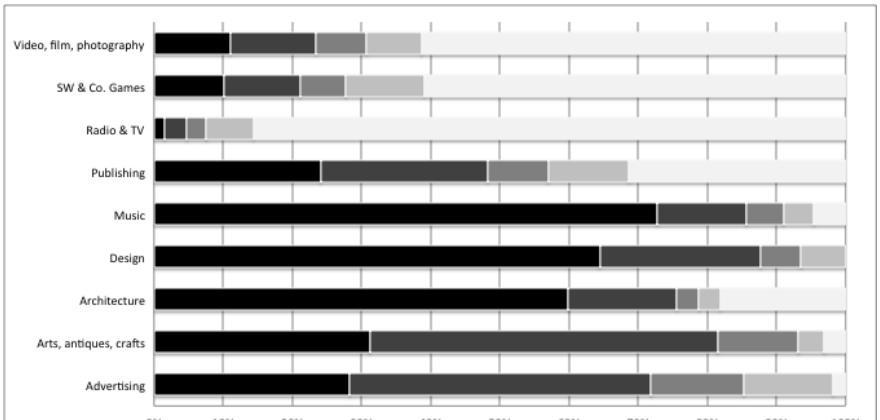



**a** **b**

**Figure 1.** Distribution of firms (a), and employees (b) in the creative categories, by layer, in 2007. Source: ASIA-UL.

As it can be noticed from the simple statistics reported above, creative categories proposed by the DCMS definition bring together groups of economic activities that reveal remarkable differences both in terms of specific weight of the various sectors, and in terms of layer composition. The number of firms is dominated in the core activities by two creative categories: Architecture and Software and computer games. 'Traditional' cultural industries are represented to a large extent by Music and performing arts, and Video, film and photography. Amongst support activities it is worth to mention the weight of construction firms (L4) in the value chain of Architecture and that of retail of fashion products (L5) in the value chain of Design. Employment in the creative sector is dominated by Software and computer games and by the audio-visuals: Video, film and photography as well as Radio and television. In analogy with the number of firms, employment in the support activities is dominated by the construction firms (L4) in the value chain of Architecture and by the retail of fashion products (L5) in the value chain of Design.

Creative categories greatly differ in terms of firm size. We look closely at this feature for the core activities in Figure 2, noticing that: Architecture, Design, Arts, antiques and Crafts, Advertising, are dominated by the presence of single employee firms and micro firms (up to 10 employees). The audio-visuals: Video, film, photography and, in particular, Radio and television are strongly dominated by the presence of large firms (more than 50 employees). The same holds true for Software and computer games.




| | Advertising | Arts, antiques, crafts | Architecture | Design | Music | Publishing | Radio & TV | SW & Co. Games | Video, film, photography |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1064.28 | 1335.8 | 10409.77 | 1304.61 | 4580 | 2067.3 | 162.09 | 3949.1 | 1608.44 |
| 2-10 | 1635.08 | 2154.25 | 2716.39 | 470.76 | 813.38 | 2077.66 | 346.14 | 4317.76 | 1807.79 |
| 11-20 | 503.45 | 502.03 | 564.64 | 117.65 | 336.35 | 754.38 | 304.96 | 2596.19 | 1072.41 |
| 21-50 | 484.46 | 157.68 | 535.41 | 131 | 275 | 1002.48 | 725.21 | 4443.18 | 1159.56 |
| >50 | 68.22 | 133.3 | 3144.84 | | 292.16 | 2690.77 | 9165.35 | 23837.51 | 8961.79 |

**Figure 2.** Distribution of employees in creative categories, by class, in 2007. Source: ASIA-UL.

It is therefore predictable that different creative categories, although rooted in the urban structure, would establish with it different relationships, resulting in different spatial distributions. We first look at the spatial distribution of the creative sector taken as a whole, afterwards we describe some relevant characteristics of single creative subcategories and comment the differences between them. Findings will support the empirical analysis interpretation presented in the following chapter.

Figure 3 shows the location quotients (LQ) of creative industries in the Metropolitan area of Rome. Standard LQ (De Propris et al., 2009) is an aggregated measure utilized for mapping the specialisation level of spatial units[2]. It is calculated by computing the ratio between the local (municipal/district) share of the creative industry and the industry's share at metropolitan level. LQ values above one indicates that the local unit has a higher share of creative industry than the metropolitan area as a whole. With respect to the previously described definition of creative industries, the activities considered are those intrinsically creative, located at the top of each supply chain (Layer 1) and those, which directly support layer one activities in the supply chain (Layer 2).

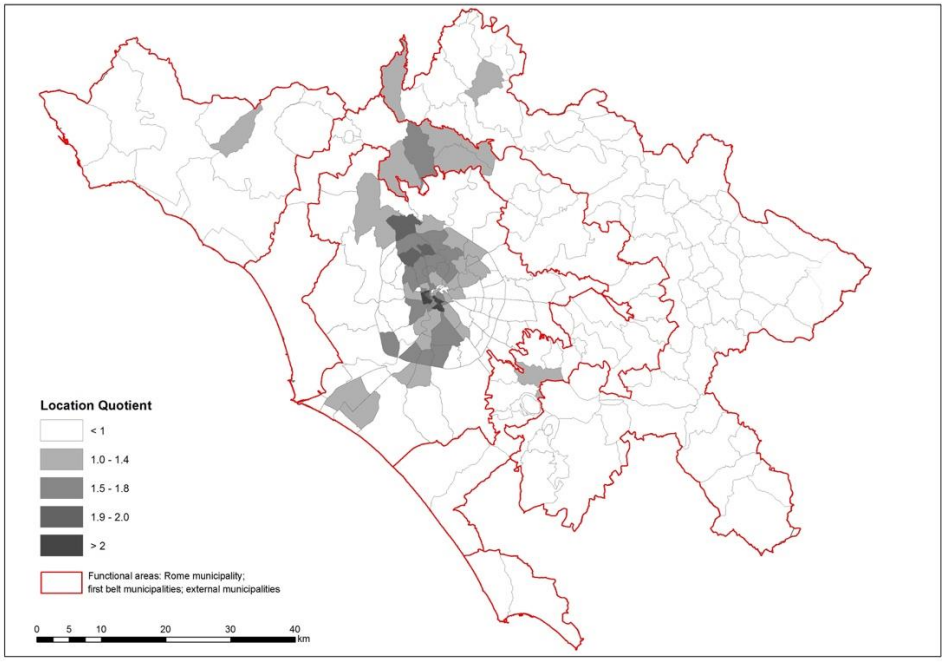



**Figure 3.** LQ of creative firms in 2007. Source: ASIA-UL.

We observe that territorial units with higher share of creative industries are located in form of a cluster with an elongated shape disposed north-south. This spatial arrangement involves most of the consolidated city, part of the southern regions towards the See, and some northern regions along the Via Cassia, in first instance, and then along the motorway A1. Being not sensitive to absolute values, the LQ index cannot offer a real picture of clusters. Conversely, the mapping of each point location would give a correct perception about the spatial extension of clusters, but not about their intensity. Kernel density mapping accounts for both intensity and spatial extension of the observed phenomena. Distance-based statistical tools used in point-pattern analysis are rooted in the kernel concept.

Figure 4 represents the Kernel density estimation depicting the cumulative incidence of creative firms over a gridded surface of the study area. Conceptually, a smoothly curved surface is fitted over each point. The surface value is highest at the location of the point and diminishes with increasing distance from the point, reaching zero at the maximum search

[2] Due to its large extension, if compared to the rest of the municipalities in the study area, the Municipality of Rome has been further subdivided in urban districts, according to the census nomenclature.

radius distance from the point[3]. The perception of cluster in Figure 4 is different from the one in Figure 3. The spatial extension covers the entire consolidated city and extends beyond the municipal limits in territories that correspond to some of the first-belt municipalities. Spatial concentrations of creative industries are almost absent in peripheral regions of the Metropolitan area. Intensity peaks are clearly visible in Rome's city centre (Prati and Parioli neighbourhoods), in the northern quartier of Fidene, in the southern quartier of EUR, as well as along the motorway that conducts to the Fiumicino airport.

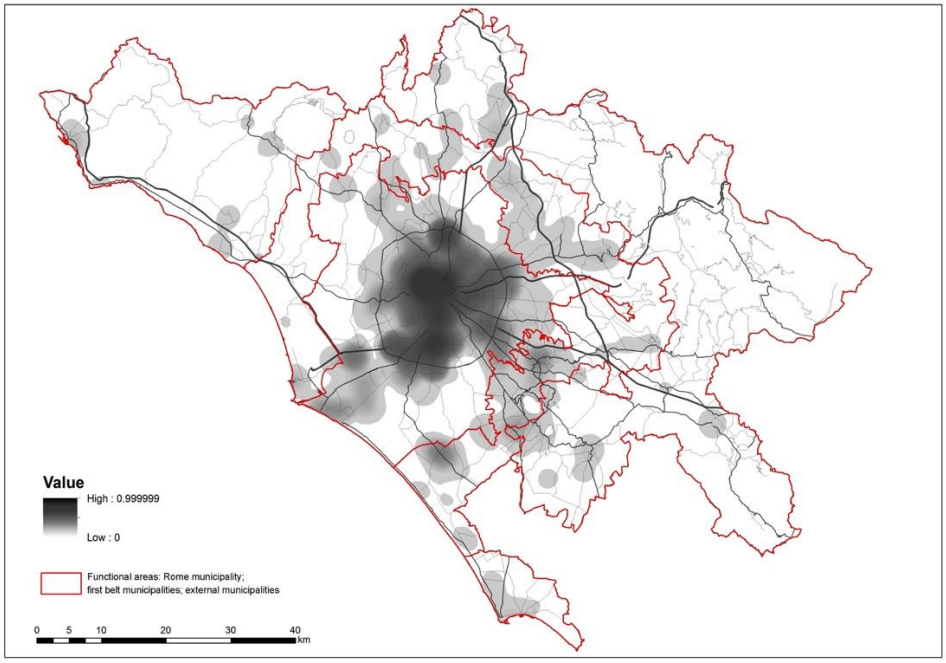



**Figure 4.** Kernel function for the creative firms in 2007. Source: ASIA-UL.

For the single creative sectors, whose Kernel functions are produced separately[4], we can summarise the following: Advertising, Architecture, Design, Music and performing arts, are spatially distributed in accordance to the urban form and extension. Architecture has three different intensity peaks, while the rest of the sectors only one, centrally located, peak. Publishing as well as Arts, antiques and crafts show a similar monocentric distribution pattern, similar to the above-described activities, but their spatial extension is far more reduced. Software and computer games barycentre is in the southern quartier of EUR, in discordance with the rest of the creative sectors. This sector also displays a significant offshoot along the motorway that conducts to the Fiumicino airport. Radio and television

[3] Kernel density estimation was performed with the Spatial Analyst Extension for ArcGIS 10. ArcGIS employs the quadratic kernel function described in Silverman (1986):

$$f(x) = \frac{1}{nh}\sum_{i=1}^{n} H\left(\frac{x - x_i}{h}\right)$$

Where $h$ is the bandwidth, $x_i$ is the Euclidean distance between type $i$ firms. $K$ is the quadratic kernel function, which is defined as: $H(x) = -\frac{3}{4}(1 - x^2), |x| \leq 1$; $K(x) = 0, x > 1$. We chose a bandwidth (kernel) of 40 km with an output cell size of 100x100m.

[4] Maps are not reported for lack of space.

and Video, film and photography are both highly concentrated in the city centre, both revealing multiple intensity peaks.

The mapping exercise has highlighted the fact that Rome's city centre hosts the largest number of creative activities. Areas of influence of different creative categories have different spatial form and behaviour, but they overlap. Cartographic representation of spatially distributed phenomena is useful in discovering relationships amongst distributions. These relationships can be further developed through specific statistical techniques that aim at identifying patterns in spatial data.

## 5 Empirical analysis

The empirical part of this paper is devoted to the study of the location patterns of different creative sub-sectors. We identify and interpret mutual relationships amongst these groups of activities, as well as their interactions with the respective service sectors. Thus, analysis focuses on bivariate spatial point patterns.

The selected method to test for industry localization depends on the hypothesis made over the nature of the spatial relationships. Bivariate spatial patterns may be interpreted in terms of exogenous factors influencing both types of economic activities, which lead to joint-localization, or in terms of attraction-repulsion amongst them, which leads to co-localization.

According to Duranton and Overman (2005), tests of industry localization should rely on a measure which: (i) is comparable across the firm types; (ii) controls for the overall agglomeration of firms; (iii) controls for individual concentration; (iv) is unbiased respect to the scale of agglomeration; (v) gives an indication of the significance of the results.

In the context of analysing the localization characteristics of two different types of industries, distance-based methods have the significant advantage of detecting spatial structure at every scale: geographic concentration or dispersion of firms in space is reported independently from the scale of phenomenon (property [iv]). Marcon and Puech (2010) identify two principal groups of distance-based methods used in the economic literature:

i. The *probability density function* utilised by Duranton and Overman (2005). This measure is based on the average number of neighbours at each distance, smoothed and normalized so that it sums up to 1.
ii. The *cumulative distance-based methods* based on Ripley's *K*-function (1976, 1977), Besag's *L* function (1977) and their extensions based on the second-order property of point patterns (Barff, 1987; Arbia, 1989; Espa et. al., 2010a; Espa et. al., 2010b). These functions describe geographic concentration by counting the average number of neighbours on every possible circle with a given radius.

Despite some limitations, cumulative distance-based methods based on Ripley's *K*-function are the most widely used in empirical economic applications. A principal drawback of these methods is related to the fact that they are generally applied to relative concentrations (i.e. detect whether each industry is overrepresented or underrepresented with respect to a baseline distribution), but they refer literally to absolute concentrations, being based on the null hypothesis of completely random spatial distribution of

establishments (i.e. plants are distributed uniformly and independently). Property [iii] defned by Duranton and Overman (2005) is usually fulfilled by comparing a sector's distribution with the overall location pattern of industries, yet, Marcon and Puech (2003) maintain that these statistical tools effectively measure the existence of specialized areas only. Another issue is related to the fact that distance-based methods most often do not consider the size of industries (property [ii]), although adaptations of Ripley's *K*-function to include marked point-patterns that account for industry size, have been proposed in order to overcome this problem (Espa et al., 2010b).

One of the most important concerns about the application of distance-based functions to point-patterns of economic activities is the fact that economic space is heterogeneous. The presence of geographic features such as water bodies or protected areas, where firms cannot locate, is a clear contraindication for the use of statistical methods, which are based on the null hypothesis of completely random spatial distribution of establishments. This aspect is even more enhanced when working with point-patterns at urban/neighbourhood scale. In these cases, we should account for the fact that firm localization is subject to precise spatial constraints, related to the physical composition of built-up units.

It is possible to account for space heterogeneity by assuming a null hypothesis of *random labelling* (Diggle and Chetwynd, 1991; Marcon and Puech, 2003; Espa et al., 2010a). This hypothesis implies that the location of firms is fixed, while their sector of activity is distributed randomly. The reference framework is the marked point process (Diggle, 1983) that, besides of the point location, accounts for point characteristics (e.g. type *i*; type *j*).

*5.1 Analysing the aggregative properties of creative sectors*

We first look at the characteristics of the spatial distribution of different creative sub-sectors with respect to the rest of creative activities in the study area. The null hypothesis is the one of random labelling, as proposed by Diggle and Chetwynd (1991), i.e. a firm can belong randomly to one creative sector or to the rest of the creative activities. Under this hypothesis, at any distance $d$, $K_s(d) = K_C(d)$, where $K_s(d)$ and $K_C(d)$ are Ripley's *K*-functions for the single creative sector and for the rest of creative economy respectively. The distance-based function is defined as:

$$D_s(d) = K_s(d) - K_C(d) \tag{3}$$

Such a difference can help in identifying creative sectors that are over–concentrated (over–dispersed) conditionally upon the spatial pattern displayed by the rest of the creative economy in the study area. *D* detects the occurrence of statistically significant concentration or dispersion of each creative subsector with the increasing of distance.

Confidence intervals, at a significance level $\alpha = 0.05$, are generated using Monte Carlo simulations, by keeping firm's location unchanged and by randomly assigning the labels that characterize each sector. We apply *D* function in a study area of 100x150 km that comprises the Metropolitan City of Rome. The distance $d$ is considered 50 km (ibid.). Behaviours of the estimated *D* functions for each creative sub-sector compared to the rest of creative economy are reported in Appendix 2. In each graph, the continuous line is the estimated *D* function, namely the difference between the estimated *K* function for one creative sub-sector and the estimated *K* function for the rest of creative activities. The dotted

lines are the simulated confidence bands. They represent the maximum and minimum values *D* function assumes, after a sequence of 999 random labelling of the two-point data sets (Rowlingson and Diggle, 1993).

There are three clearly distinguishable distribution patterns of creative sub-sectors observed in the study area:

iii. over-concentration of one creative sub sector when compared to the rest of the creative sectors occurs when the estimated D curve lies above the maximum envelope curve;
iv. random labelling of one creative sub sector when compared to the rest of the creative sectors occurs when the estimated D curve lies in-between the maximum and minimum envelope curves;
v. over-dispersion of one creative sub sector when compared to the rest of the creative sectors occurs when the estimated D curve lies below the minimum envelope curve.

Table 2 reassumes the observed spatial behaviours for all the creative sub-sectors. The third and fourth columns indicate the existence of concentration and dispersion patterns, respectively, and the distance at which these phenomena occur. The fifth column evidences the distance at which intensity peaks are observed. The lack of reference values both for concentration and for dispersion patterns evidences random labelling of one subsector when compared to the spatial distribution of rest of creative activities.

From Table 2 we learn that: Advertising; Arts, antiques and crafts; Music and performing arts; Publishing; Radio and television; Video, film and photography, display a pattern of *significant concentration* when compared to the spatial distribution of rest of creative activities; Software and computer games has a spatial pattern of *significant dispersion*; Architecture and Design are *randomly labelled*. The distance at which there is significant concentration differs greatly between the various creative sectors. A common characteristic is the existence of only one concentration peak for all non-randomly labelled categories. This feature derives from the strong monocentric pattern of Rome's Metropolitan area.

**Table 2.** Concentration-dispersion characteristics for each creative sector in the Metropolitan area of Rome.

| | **N. firms** | **Concentration** | **Dispersion** | **Peak** |
|---|---|---|---|---|
| Advertising | 2052 | 0-7.5 km | -- | 6.5 km |
| Architecture | 11562 | -- | -- | -- |
| Arts, antiques and crafts | 4108 | 0-11 km | -- | 5 km |
| Design | 1522 | -- | -- | -- |
| Music and performing arts | 4921 | 0-48 km | -- | 10 km |
| Publishing | 2789 | 0-40 km | -- | 8 km |
| Radio and TV | 322 | 0-12 km | -- | 8 km |
| Software and computer games | 5781 | -- | 0-15 km | 9 km |
| Video, film and photography | 2340 | 0-33 km | -- | 8 km |

The localization characteristics displayed by the different creative sectors are interesting to comment in the light of the strong differences between the components. The arts and the media, which are the 'traditional' categories of the 'cultural' economy, have a clear tendency to agglomerate if compared to the totality of the creative activities of the city. Creative sectors such as the Architecture and Design, which are dominated by the micro firms (see Figure 2), are randomly labelled. Software and computer games is the only sector showing a dispersive pattern relative to the rest of the creative components. As we will discuss further on, when it comes to definition issues, this is the most controversial sector.

*5.2 Core-periphery relationships within the value chains*

Production chains affect industrial clustering. In the case of creative industries, testing for co-localization between content-creation creative activities and related support activities, such as the production and distribution of complementary outputs, would offer evidence about the spatial relationships that creative activities in the different creative economic sectors hold with the support activities in the value chain.

In the presence of a bivariate point process (with points marked as type $i$ and type $j$), at any distance $d$, we have two typologies of events and two distinct types of $K$-functions: the univariate Ripley's $K$-functions for each marked point subset $K_{\mathrm{i}}(d)$ and $K_{\mathrm{j}}(d)$, and the bivariate functions $K_{\mathrm{ij}}(d)$ and $K_{\mathrm{ji}}(d)$.

Under the null hypothesis of random labelling we have $K_{ij}(d) = K_{ji}(d) = K_i(d) = K_j(d) = K(d)$, meaning that all the bivariate and univariate $K$-functions of marked point subsets coincide with the univariate $K$-function obtained by the whole point-pattern.

The null hypothesis is tested by performing the differences between estimators: $\widehat{K}_i(d) - \widehat{K}_{ij}(d)$ and $\widehat{K}_i(d) - \widehat{K}_{ji}(d)$. Arbia et al. (2007) argue that these differences are more informative than the simple difference $\widehat{K}_i(d) - \widehat{K}_j(d)$, suggested by Diggle and Chetwynd (1991), because they allow for a better characterisation of the mutual spatial relationships between the two marked point patterns. For example, when $\widehat{K}_i(d) > \widehat{K}_{ij}(d)$ and $\widehat{K}_i(d) > \widehat{K}_{ji}(d)$ both type i and type j industries show a tendency of segregation within mono-type clusters. Confidence intervals, at a significance level $\alpha = 0.05$, are generated using Monte Carlo simulations, by keeping firm's location unchanged and by randomly assigning the labels that characterize each sector.

We test a null hypothesis of random labelling by comparing, for each creative category, localization patterns of creative firms (L1 and L2 layers) with those of the respective service functions (L3, L4 and L5 layers). Detailed distribution of firms and employees in each layer is reported in Appendix 1. Point data is organised according to the definition described in Section 4, adapted for the Italian 5-digit ATECO codes for the observation year 2007. Content creation activities (L1, L2) are marked as 'core' activities, while the rest of firms (L3, L4, L5) are marked as 'support' activities.

Table 3 summarises the concentration-dispersion characteristics derived from pairwise comparisons between the core creative industries and the service industries for each creative category. Detailed results are in Appendix 3. Note that Advertising sector is not included, since it is composed only by L1 and L2 type of economic activities.

**Table 3.** Concentration-dispersion characteristics between the core-creative and the service industries for each creative category in the Metropolitan area of Rome.

| | N. firms | Core | | Support | |
|---|---|---|---|---|---|
| | | Concentration | Dispersion | Concentration | Dispersion |
| Arts, antiques and crafts | 4108 | 0-29 km | -- | -- | 0-23 km |
| Architecture | 11562 | 0-50 km | -- | -- | 0-50 km |
| Design | 1522 | -- | -- | 0-2 km | -- |
| Music and performing arts | 4921 | 0-30 km | -- | -- | 5-8 km<br>20-42 km |
| Publishing | 2789 | 0-38 km | -- | -- | 0-39 km |
| Radio and TV | 322 | 0-14 km | -- | -- | 8-16 km |
| Software and computer games | 5781 | -- | -- | -- | -- |
| Video, film and photography | 2340 | 0-42 km | -- | -- | 0-42 km |

Three distinguishable concentration-dispersion patterns can be observed between the core-creative and the service industries for each creative category in the study area:

- Concentration of core creative activities and contextual dispersion of support activities (Architecture; Arts, antiquities and crafts activities; Publishing; Music and performing arts; Video, Film and photography; Radio and TV);
- Concentration of support creative activities and contextual dispersion of core activities (Design);
- Random labelling of core and support activities (Software and computer games).

The most striking feature in Table 3 is the fact that the service sector of Design is clustered at small distances (0-3 kilometres) while the core sector is randomly labelled. This can be explained by the fact that, as already discussed, spatial distribution of Design activities shows no strong intensity peaks or excessive spatial concentration, being the sector dominated by micro firms. On the other hand, value chain includes retailing of fashion and design products, whose tendency to locate in central neighbourhoods is well known. However, interpretation of these results is by no means straightforward. The design sector in the classification scheme based on the DCMS mapping document appears ill assorted when adapted to the Italian case: the Ateco codes do not allow for distinction amongst fashion design and industrial design (these categories are merged in code 74.10.1) and identifiable activities in the value chain include the fashion sector only. Analogies with the Design sector were also noted in the above discussed problematic sector of Software and computer games, which results randomly labelled in relation to its service activities.

Architecture deserves perhaps a separate comment, considering the fact that its supporting sector gathers the largest number both of firms and employees (Figures 1 and 2). The leader-follower relationship between core and service activities emerges clearly at all distances. This statistical evidence is explained by the fact that service activities within the value chain of Architecture are mainly represented by small but numerous construction firms. In this case the hinterland region is representative in terms of hosting a significant

number of economic activities if compared to the central urban agglomeration. In this case it is possible to describe a core creative sector clustered in space and a service sector dispersed internally and disposed around the core.

This observation holds true also for all the 'traditional' cultural sectors: Arts, antiquities and crafts activities; Publishing; Music and performing arts; Video, film and photography; Radio and television. Analysis results for these latest categories perhaps can be interpreted with greater conviction, in the light of the fact that sector boundaries are more consolidated and reliable.

## 6 Conclusions

This paper addressed the use of distance-based statistical methods to analyse the location patterns of creative industries. The spatial distribution of creative industries in the Metropolitan City of Rome is studied by utilising spatially referenced point data as input to a statistical model based on Ripley's *K*-function. Pairwise differences between *K*-functions of observed point patterns are computed and compared with simulated confidence bands. A null hypothesis of random labelling is tested upon two conditions: by analysing the spatial distribution of different creative sectors with respect to the rest of the creative industry and by comparing, for each creative subcategory, localization patterns of creative firms with respect to the localization of respective service functions. Exhaustive establishment level data from the Statistical Archive of Local Units of Active Enterprises (ASIA-UL) provided by the National Institute of Statistics is used in the analysis.

While looking at the spatial relationships that each creative category holds with the rest of the creative economy, we observe that six out of the nine creative sectors display a pattern of significant concentration. In detail, this holds true for: Advertising; Arts, antiques and crafts; Music and performing arts; Publishing; Radio and television; Video, film and photography. Instead, Software and computer games shows significant dispersion, while Architecture and Design are randomly labelled.

This statistical evidence highlights the fact that macro components of the creative industry, as defined by the DCMS (1998) classification, and similarly by many other national and international institutions, clearly reveal different spatial arrangements: the arts and the media, which are the 'traditional' categories of the 'cultural industry', show a higher tendency to agglomerate if compared to the totality of the creative activities of the city. Creative sectors such as Architecture and Design, which are dominated by the micro firms, are randomly labelled. Software and computer games is the only sector showing a dispersive pattern when compared to the rest of the creative components. These structural spatial characteristics are reflected also in the relationships between different creative sectors and between core-creative activities and their respective support activities.

When looking at the pairwise comparisons between the creative sectors and their respective service sectors, the following situation emerges: six out of eight possible pairs of point patterns display a situation of dominance of the creative sector on the service sector. The leader-follower type of relationship is displayed by: Architecture; Arts, antiques and crafts; Publishing; Music and performing arts; Video, Film and photography; Radio and television. This type of relationship between 'core' and 'peripheral' economic activities

within the creative value chains can be interpreted in terms of mutual relationships that are influenced by the urban milieu. Generally creative firms tend to locate in central neighbourhoods characterized by the high quality of architecture and streetscape and a high density of urban functions. On the other hand, many service activities, despite the requisite for spatial proximity with the core creative sector, are more sensitive to urban real estate values and/or accessibility to transportation infrastructures.

The results obtained have shown the utility of empirical analysis based on spatial statistics in the analysis of detailed patterns of creative industries. Empirical evidence is provided about the tendency to cluster shown by different creative sectors, about the spatial interaction amongst specific creative activities and about the co-localisation of industries within the value chains. This site-specific type of analysis would gain much from the confrontation with empirical evidence obtained in other, different spatial contexts, both at national and international levels.

Another consideration to be made when introducing this approach to the study of the creative sector regards the existence of conceptual problems deriving from the lack of a clear-cut definition of what creativity is meant to entail from an economic perspective. This leads to confusing evidence about the weight of the creative sector and the relative significance of its components, but also to distorted visions on the relationships amongst creative activities and their spatial context. This latest aspect was evidenced also by the analytical results, showing how creative categories whose boundaries are not precisely drawn as a result of definition dilemma or problems with the (SIC) codes not being able to distinguish amongst the components return statistical evidence that is difficult to interpret.

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**APPENDIX 1**

ATECO codes and description of creative industries per Category and Layer.
Source: ISTAT – Business register 2007 – Province of Rome

ADVERTIZING

| Ateco code | Layer | Description | N. firms | N. employees |
|---|---|---|---|---|
| 73.11.0 | L1 | Agenzie pubblicitarie | 1650 | 3755.49 |
| 73.12.0 | L2 | Attività delle concessionarie e degli altri intermediari di servizi pubblicitari | 402 | 1141.8 |
| **Grand total** | | | **2052** | **4897.29** |

ARCHITECTURE

| Ateco code | Layer | Description | N. firms | N. employees |
|---|---|---|---|---|
| 71.11.0 | L1 | Attività degli studi di architettura | 6831 | 7296.58 |
| 71.12.1 | L2 | Attività degli studi di ingegneria | 3744 | 4653.4 |
| 71.12.2 | L2 | Servizi di progettazione di ingegneria integrata | 987 | 5421.07 |
| 71.12.3 | L3 | Attività tecniche svolte da geometri | 2810 | 3058.87 |
| 71.12.4 | L3 | Attività di cartografia e aerofotogrammetria | 86 | 210.51 |
| 71.12.5 | L3 | Attività di studio geologico e di prospezione geognostica e mineraria | 217 | 427.25 |
| 41.10.0 | L4 | Sviluppo di progetti immobiliari senza costruzione | 639 | 1387.99 |
| 41.20.0 | L4 | Costruzione di edifici residenziali e non residenziali | 11037 | 41307.62 |
| 42.11.0 | L4 | Costruzione di strade, autostrade e piste aeroportuali | 264 | 2054.51 |
| 42.12.0 | L4 | Costruzione di linee ferroviarie e metropolitane | 40 | 507.27 |
| 42.13.0 | L4 | Costruzione di ponti e gallerie | 49 | 448.12 |
| 42.21.0 | L4 | Costruzione di opere di pubblica utilità per il trasporto di fluidi | 17 | 759.33 |
| 42.22.0 | L4 | Costruzione di opere di pubblica utilità per l'energia elettrica e le telecomunicazioni | 14 | 1241.64 |
| 42.91.0 | L4 | Costruzione di opere idrauliche | 78 | 537.29 |
| 42.99.0 | L4 | Costruzione di altre opere di ingegneria civile n.c.a. | 160 | 801.71 |
| 43.21.0 | L4 | Installazione di impianti elettrici ed elettronici (inclusa manutenzione e riparazione) | 4396 | 16808.91 |
| 43.22.0 | L4 | Installazione di impianti idraulici, di riscaldamento e di condizionamento dell'aria | 4117 | 12075.35 |
| 43.29.0 | L4 | Altri lavori di costruzione e installazione | 1198 | 4351.64 |
| 43.31.0 | L4 | Intonacatura e stuccatura | 602 | 1481.61 |
| 43.32.0 | L4 | Posa in opera di infissi, arredi, controsoffitti, pareti mobili e simili | 1002 | 2222.68 |
| 43.33.0 | L4 | Rivestimento di pavimenti e di muri | 1402 | 2611.91 |
| 43.34.0 | L4 | Tinteggiatura e posa in opera di vetri | 1452 | 2614.42 |
| 43.39.0 | L4 | Altri lavori di completamento e di finitura degli edifici | 8539 | 21854.32 |
| 43.91.0 | L4 | Realizzazione di coperture | 169 | 620.64 |
| 43.99.0 | L4 | Altri lavori specializzati di costruzione n.c.a. | 577 | 3081.23 |
| 46.13.0 | L4 | Intermediari del commercio di legname e materiali da costruzione | 949 | 1269.02 |
| 46.73.1 | L4 | Commercio all'ingrosso di legname, semilavorati in legno e legno artificiale | 168 | 615.68 |
| 46.73.2 | L4 | Commercio all'ingrosso di materiali da costruzione | 613 | 2962.88 |
| 46.73.3 | L4 | Commercio all'ingrosso di vetro piano | 7 | 27.66 |
| 46.73.4 | L4 | Commercio all'ingrosso di carta da parati, colori e vernici | 132 | 356.2 |
| 70.10.0 | L4 | Attività delle holding impegnate nelle attività gestionali (holding operative) | 151 | 3147.49 |
| 71.20.1 | L4 | Collaudi ed analisi tecniche di prodotti | 181 | 519.78 |
| 71.20.2 | L4 | Controllo di qualità e certificazione di prodotti, processi e sistemi | 267 | 711.74 |
| *Total core* | | | *11562* | *17371.05* |
| *Total support* | | | *41333* | *130075.27* |
| **Grand total** | | | **52895** | **147446.32** |

ARTS, ANTIQUES AND CRAFTS ACTIVITIES

| Ateco code | Layer | Description | N. firms | N. employees |
|---|---|---|---|---|
| 47.78.3 | L2 | Commercio al dettaglio di oggetti d'arte di culto e di decorazione, chincaglieria e bigiotteria | 1128 | 2102.71 |
| 47.79.2 | L2 | Commercio al dettaglio di mobili usati e oggetti di antiquariato | 336 | 404.85 |
| *47.77.0* | *L2* | *Commercio al dettaglio di orologi, articoli di gioielleria e argenteria* | *1963* | *3643.73* |
| 82.30.0 | L2 | Organizzazione di convegni e fiere | 681 | 1775.5 |
| 15.12.0 | L3 | Fabbricazione di articoli da viaggio, borse e simili, pelletteria e selleria | 116 | 289.82 |
| 15.20.1 | L3 | Fabbricazione di calzature | 31 | 60.19 |
| 15.20.2 | L3 | Fabbricazione di parti in cuoio per calzature | 9 | 26.28 |
| 24.41.0 | L3 | Produzione di metalli preziosi e semilavorati | 10 | 16.14 |
| 32.12.1 | L3 | Fabbricazione di oggetti di gioielleria ed oreficeria in metalli preziosi o rivestiti di metalli preziosi | 487 | 800.86 |
| 32.12.2 | L3 | Lavorazione di pietre preziose e semipreziose per gioielleria e per uso industriale | 33 | 48.49 |
| 32.13.0 | L3 | Fabbricazione di bigiotteria e articoli simili | 149 | 182.17 |
| 32.20.0 | L3 | Fabbricazione di strumenti musicali (incluse parti e accessori) | 14 | 17.34 |
| 13.93.0 | L4 | Fabbricazione di tappeti e moquette | 6 | 28.83 |
| 23.31.0 | L4 | Fabbricazione di piastrelle in ceramica per pavimenti e rivestimenti | 3 | 46.83 |
| 23.41.0 | L4 | Fabbricazione di prodotti in ceramica per usi domestici e ornamentali | 59 | 102.77 |
| 23.70.2 | L4 | Lavorazione artistica del marmo e di altre pietre affini, lavori in mosaico | 124 | 408.93 |
| 46.47.2 | L4 | Commercio all'ingrosso di tappeti | 11 | 12.5 |
| 46.48.0 | L4 | Commercio all'ingrosso di orologi e di gioielleria | 232 | 570.58 |
| *Total core* | | | *4108* | *7926.79* |
| *Total support* | | | *1284* | *2611.73* |
| **Grand total** | | | **5392** | **10538.52** |

DESIGN

| Ateco code | Layer | Description | N. firms | N. employees |
|---|---|---|---|---|
| 74.10.1 | L1 | Attività di design di moda e design industriale | 362 | 491.15 |
| 74.10.2 | L1 | Attività dei disegnatori grafici | 785 | 1082.05 |
| 74.10.3 | L1 | Attività dei disegnatori tecnici | 244 | 249.38 |
| 74.10.9 | L1 | Altre attività di design | 131 | 201.44 |
| 14.11.0 | L3 | Confezione di abbigliamento in pelle e similpelle | 31 | 81.91 |
| 14.13.1 | L3 | Confezione in serie di abbigliamento esterno | 341 | 1284.17 |
| 14.13.2 | L3 | Sartoria e confezione su misura di abbigliamento esterno | 402 | 939.81 |
| 14.14.0 | L3 | Confezione di camicie, T-shirt, corsetteria e altra biancheria intima | 83 | 462.16 |
| 14.19.1 | L3 | Confezioni varie e accessori per l'abbigliamento | 128 | 258.39 |
| 14.19.2 | L3 | Confezioni di abbigliamento sportivo o indumenti particolari | 104 | 296.24 |
| 14.20.0 | L3 | Confezione di articoli in pelliccia | 66 | 92.01 |
| 13.10.0 | L4 | Preparazione e filatura di fibre tessili | 4 | 4.33 |
| 13.20.0 | L4 | Tessitura | 13 | 29.08 |
| 13.30.0 | L4 | Finissaggio dei tessili, degli articoli di vestiario e attività similari | 8 | 16.69 |
| 15.11.0 | L4 | Preparazione e concia del cuoio e pelle; preparazione e tintura di pellicce | 8 | 14 |
| 46.16.0 | L4 | Intermediari del commercio di prodotti tessili, abbigliamento, pellicce, calzature e articoli in pelle | 1720 | 2213.5 |
| 46.24.2 | L4 | Commercio all'ingrosso di pelli gregge e lavorate per pellicceria | 9 | 9 |
| 46.42.1 | L4 | Commercio all'ingrosso di abbigliamento e accessori | 1116 | 2944.49 |
| 46.42.2 | L4 | Commercio all'ingrosso di articoli in pelliccia | 10 | 26.32 |
| 46.42.3 | L4 | Commercio all'ingrosso di camicie, biancheria intima, maglieria e simili | 84 | 163.64 |
| 46.42.4 | L4 | Commercio all'ingrosso di calzature e accessori | 155 | 276.14 |

| | | | | |
|---|---|---|---|---|
| 46.49.5 | L4 | Commercio all'ingrosso di profumi e cosmetici | 52 | 138.77 |
| 47.51.1 | L5 | Commercio al dettaglio di tessuti per l'abbigliamento, l'arredamento e di biancheria per la casa | 506 | 1062.38 |
| 47.71.1 | L5 | Commercio al dettaglio di confezioni per adulti | 5819 | 15640.59 |
| 47.71.2 | L5 | Commercio al dettaglio di confezioni per bambini e neonati | 773 | 1635.39 |
| 47.71.3 | L5 | Commercio al dettaglio di biancheria personale, maglieria, camicie | 1465 | 2767.76 |
| 47.71.4 | L5 | Commercio al dettaglio di pellicce e di abbigliamento in pelle | 65 | 386.45 |
| 47.71.5 | L5 | Commercio al dettaglio di cappelli, ombrelli, guanti e cravatte | 71 | 261.81 |
| 47.72.1 | L5 | Commercio al dettaglio di calzature e accessori | 1320 | 3489.11 |
| 47.72.2 | L5 | Commercio al dettaglio di articoli di pelletteria e da viaggio | 452 | 1181.35 |
| *Total core* | | | *1522* | *2024.02* |
| *Total support* | | | *14805* | *35675.49* |
| **Grand total** | | | **16327** | **37699.51** |

MUSIC AND PERFORMING ARTS

| Ateco code | Layer | Description | N. firms | N. employees |
|---|---|---|---|---|
| 90.01.0 | L1 | Rappresentazioni artistiche | 4027 | 4615.14 |
| 90.02.0 | L2 | Creazioni artistiche e letterarie | 807 | 1118.1 |
| 90.04.0 | L2 | Gestione di teatri, sale da concerto e altre strutture artistiche | 87 | 563.65 |
| 59.20.1 | L3 | Edizione di registrazioni sonore | 161 | 270.47 |
| 59.20.3 | L3 | Edizione di musica stampata | 12 | 16.16 |
| 46.43.2 | L4 | Commercio all'ingrosso di supporti registrati, audio, video (cd, dvd e altri supporti) | 57 | 193.9 |
| 47.59.6 | L5 | Commercio al dettaglio di strumenti musicali e spartiti | 72 | 167.66 |
| 47.63.0 | L5 | Commercio al dettaglio di registrazioni musicali e video in esercizi specializzati | 157 | 317.23 |
| 93.29.9 | L5 | Altre attività di intrattenimento e di divertimento n.c.a. | 757 | 1443.16 |
| *Total core* | | | 4921 | 6296.89 |
| *Total support* | | | 1216 | 2408.58 |
| **Grand total** | | | **6137** | **8705.47** |

PUBLISHING

| Ateco code | Layer | Description | N. firms | N. employees |
|---|---|---|---|---|
| 90.03.0 | L1 | Creazioni artistiche e letterarie | 1662 | 2101.54 |
| 58.11.0 | L2 | Edizione di libri | 390 | 1477.52 |
| 58.13.0 | L2 | Edizione di quotidiani | 104 | 2402.85 |
| 58.14.0 | L2 | Edizione di riviste e periodici | 553 | 2285.21 |
| 58.19.0 | L2 | Altre attività editoriali | 80 | 325.47 |
| 18.11.0 | L3 | Stampa di giornali | 16 | 203.31 |
| 18.12.0 | L3 | Altra stampa | 1080 | 6766.6 |
| 18.13.0 | L3 | Lavorazioni preliminari alla stampa e ai media | 280 | 816.12 |
| 18.14.0 | L3 | Legatoria e servizi connessi | 148 | 693.23 |
| 63.91.0 | L3 | Attività delle agenzie di stampa | 23 | 875.33 |
| 74.30.0 | L3 | Traduzione e interpretariato | 855 | 984.47 |
| 17.12.0 | L4 | Fabbricazione di carta e cartone | 10 | 117.73 |
| 20.30.0 | L4 | Fabbricazione di pitture, vernici e smalti, inchiostri da stampa e adesivi sintetici | 33 | 170.36 |
| 47.61.0 | L5 | Commercio al dettaglio di libri nuovi in esercizi specializzati | 425 | 1571.82 |
| 47.62.1 | L5 | Commercio al dettaglio di giornali, riviste e periodici | 462 | 740.21 |
| *Total core* | | | *2789* | *8592.59* |
| *Total support* | | | *3332* | *12939.18* |
| **Grand total** | | | **6121** | **21531.77** |

RADIO AND TELEVISION

| Ateco code | Layer | Description | N. firms | N. employees |
|---|---|---|---|---|
| 60.10.0 | L1 | Trasmissioni radiofoniche | 157 | 675.98 |
| 60.20.0 | L1 | Programmazione e trasmissioni televisive | 165 | 10027.77 |

| | | | | |
|---|---|---|---|---|
| 26.30.1 | L3 | Fabbricazione di apparecchi trasmittenti radiotelevisivi (incluse le telecamere) | 26 | 122.92 |
| 26.40.0 | L4 | Fabbricazione di apparecchi per la riproduzione e registrazione del suono e delle immagini | 13 | 63.01 |
| 46.52.0 | L4 | Commercio all'ingrosso apparecchiature elettroniche per telecomunicazioni e | 229 | 1013.07 |
| 47.43.0 | L5 | Commercio al dettaglio di apparecchi audio e video in esercizi specializzati | 129 | 370.06 |
| *Total core* | | | *322* | *10703.75* |
| *Total support* | | | *397* | *1569.06* |
| **Grand total** | | | **719** | **12272.81** |

SOFTWARE AND COMPUTER GAMES

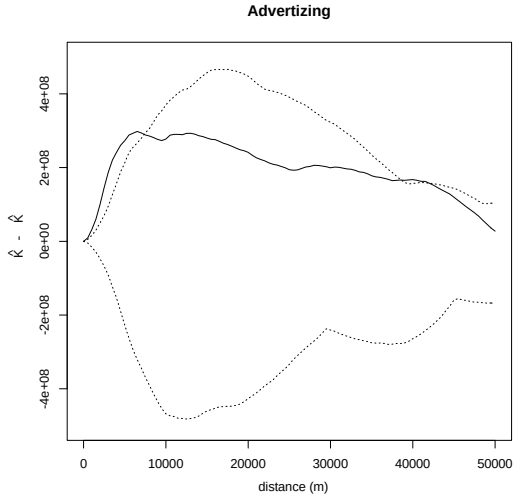
| Ateco code | Layer | Description | N. firms | N. employees |
|---|---|---|---|---|
| 32.40.1 | L1 | Fabbricazione di giochi (inclusi i giochi elettronici) | 15 | 29.36 |
| 32.40.2 | L1 | Fabbricazione di giocattoli (inclusi i tricicli e gli strumenti musicali giocattolo) | 6 | 8 |
| 62.01.0 | L1 | Produzione di software non connesso all'edizione | 2716 | 29352.43 |
| 62.02.0 | L1 | Consulenza nel settore delle tecnologie dell'informatica | 1934 | 7096.21 |
| 62.09.0 | L2 | Altre attività dei servizi connessi alle tecnologie dell'informatica | 1110 | 2657.74 |
| 58.21.0 | L3 | Edizione di giochi per computer | 4 | 34.25 |
| 58.29.0 | L3 | Edizione di altri software | 67 | 425.55 |
| 62.03.0 | L3 | Gestione di strutture e apparecchiature informatiche hardware - housing (esclusa la riparazione) | 483 | 2690.1 |
| 26.20.0 | L4 | Fabbricazione di computer e unità periferiche | 77 | 552.55 |
| 46.49.3 | L4 | Commercio all'ingrosso di giochi e giocattoli | 39 | 211.11 |
| 46.51.0 | L4 | Commercio all'ingrosso di computer, apparecchiature informatiche | 910 | 4102.49 |
| 47.19.2 | L5 | Commercio al dettaglio di computer, periferiche, telecomunicazioni, elettronica di consumo audio e video, elettrodomestici | 38 | 1019.49 |
| 47.65.0 | L5 | Commercio al dettaglio di giochi e giocattoli (inclusi quelli elettronici) | 341 | 876.08 |
| *Total core* | | | *5781* | *39143.74* |
| *Total support* | | | *1959* | *9911.62* |
| **Grand total** | | | **7740** | **49055.36** |

VIDEO, FILM AND PHOTOGRAPHY

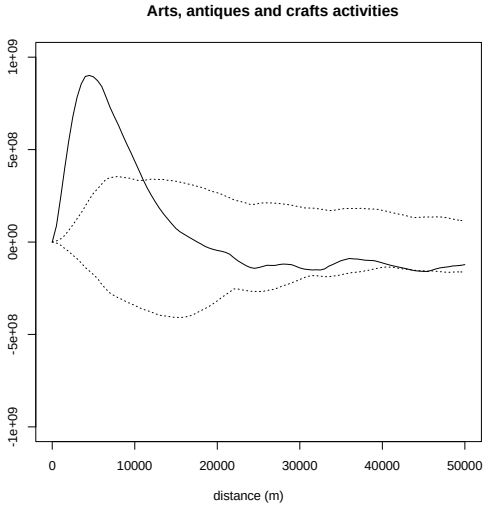
| Ateco code | Layer | Description | N. firms | N. employees |
|---|---|---|---|---|
| 59.11.0 | L1 | Attività di produzione cinematografica, di video e di programmi televisivi | 1374 | 12581.24 |
| 59.12.0 | L1 | Attività di post-produzione cinematografica, di video e di programmi televisivi | 204 | 1125.28 |
| 74.20.1 | L1 | Attività di riprese fotografiche | 762 | 903.47 |
| 18.20.0 | L3 | Riproduzione di supporti registrati | 41 | 309.14 |
| 20.59.1 | L3 | Fabbricazione di prodotti chimici per uso fotografico | 2 | 9.08 |
| 26.70.2 | L3 | Fabbricazione di apparecchiature fotografiche e cinematografiche | 9 | 226.25 |
| 26.80.0 | L3 | Fabbricazione di supporti magnetici ed ottici | 1 | 1 |
| 46.43.3 | L3 | Commercio all'ingrosso di articoli per fotografia, cinematografia e ottica | 133 | 499.81 |
| 47.78.2 | L3 | Commercio al dettaglio di materiale per ottica e fotografia | 1098 | 2106.66 |
| 59.13.0 | L3 | Attività di distribuzione cinematografica, di video e di programmi televisivi | 194 | 1511.04 |
| 59.14.0 | L5 | Attività di proiezione cinematografica | 106 | 877.02 |
| *Total core* | | | *2340* | *14609.99* |
| *Total support* | | | *1584* | *5540* |
| **Grand total** | | | **4156** | **20567.49** |

**APPENDIX 2**

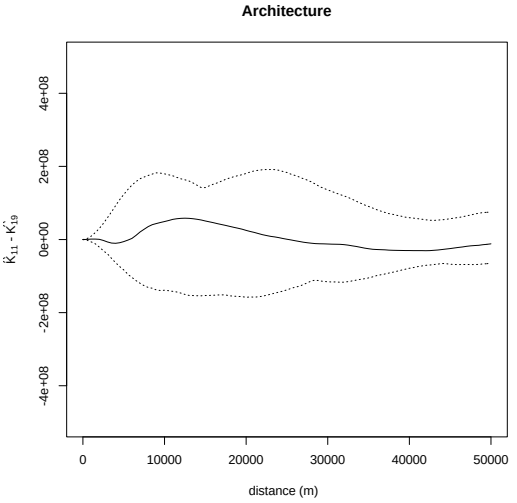
Behaviour of the statistics $\widehat{K}_s(d) - \widehat{K}_C(d)$ (solid line) and of the corresponding min and max envelopes (dashed lines) estimated on the bases of 999 random labelling.



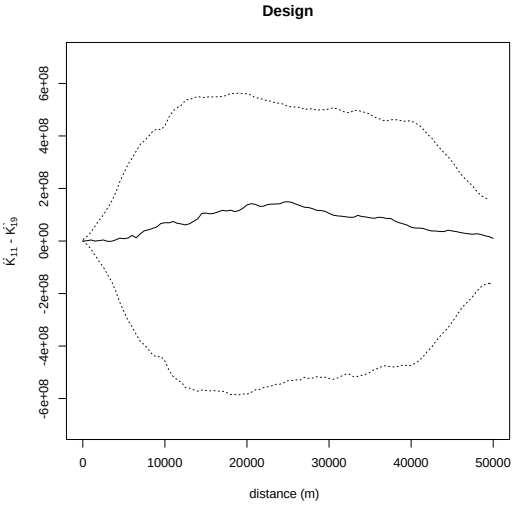

a



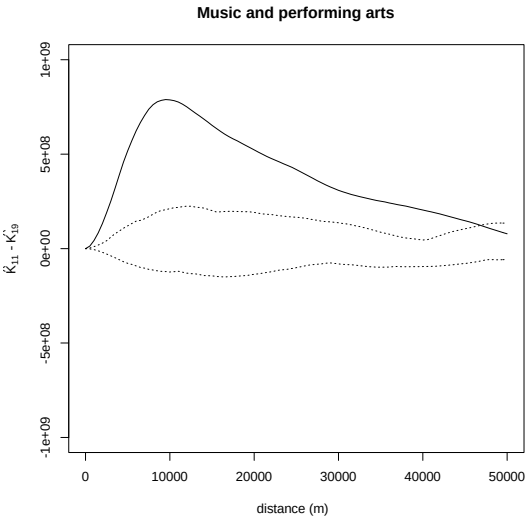

b



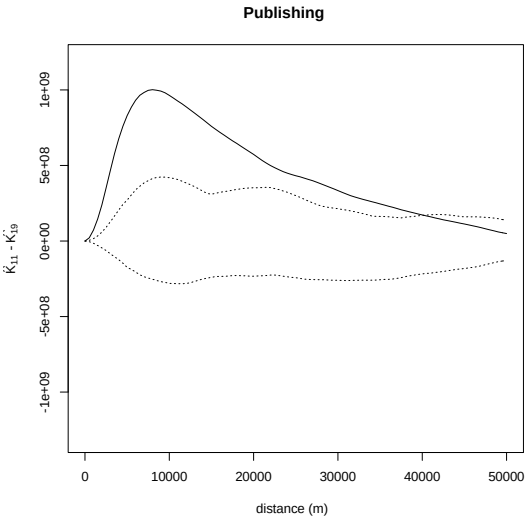

c



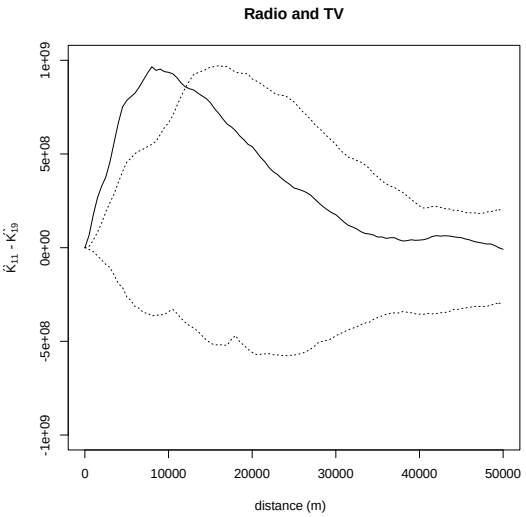

d



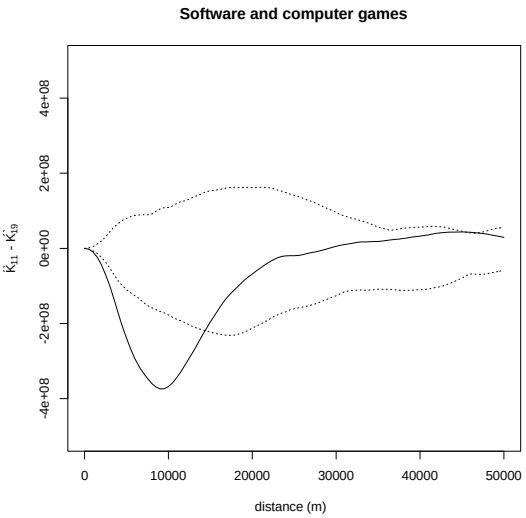

e



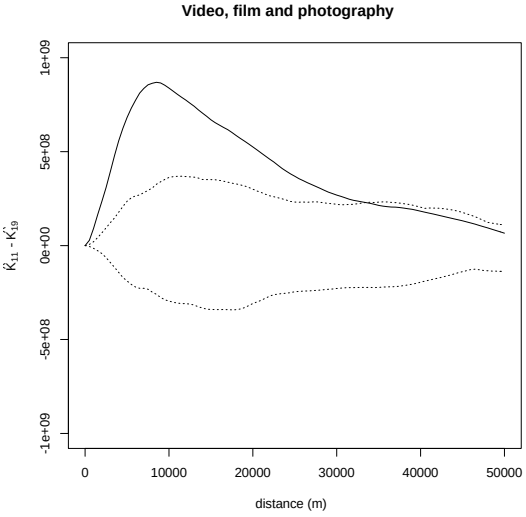

f




g



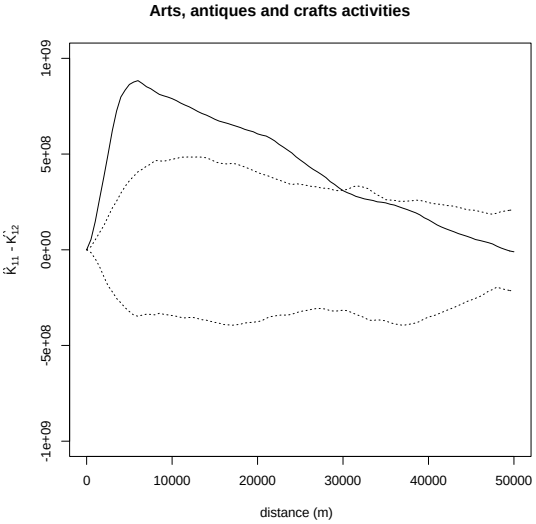

h

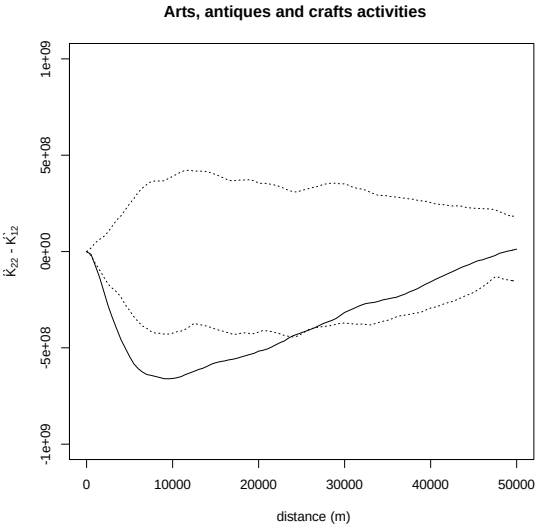



i

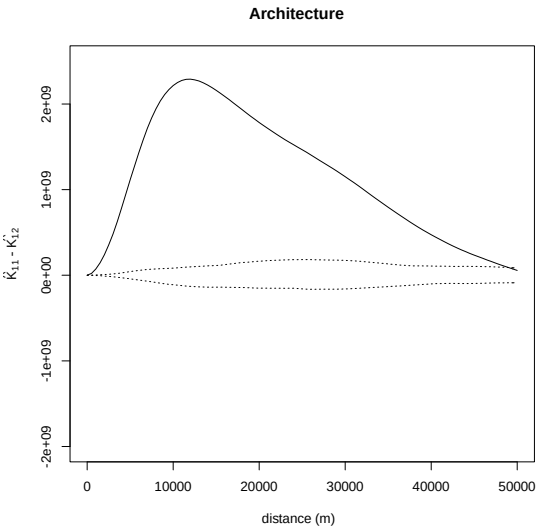
## APPENDIX 3

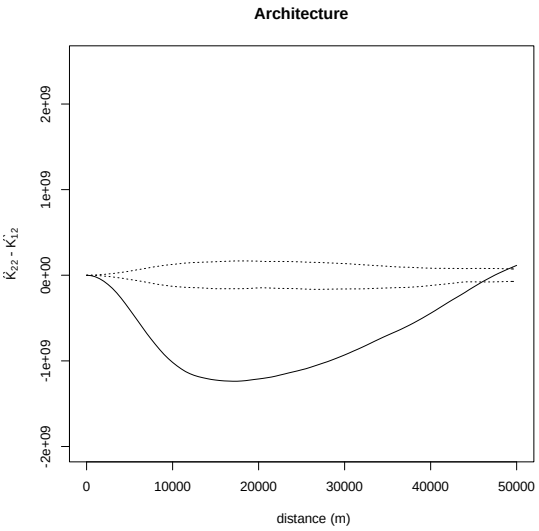
Behaviour of the statistics $\widehat{K}_{cc}(d) - \widehat{K}_{cs}(d)$ and $\widehat{K}_{ss}(d) - \widehat{K}_{sc}(d)$ (solid line) and of the corresponding min and max envelopes (dashed lines) estimated on the bases of 999 random labelling.



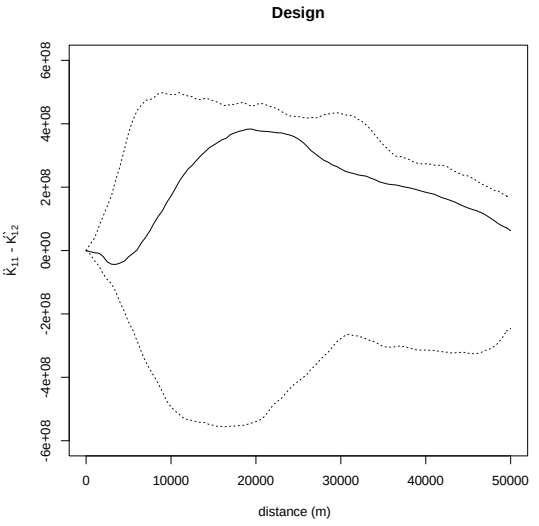



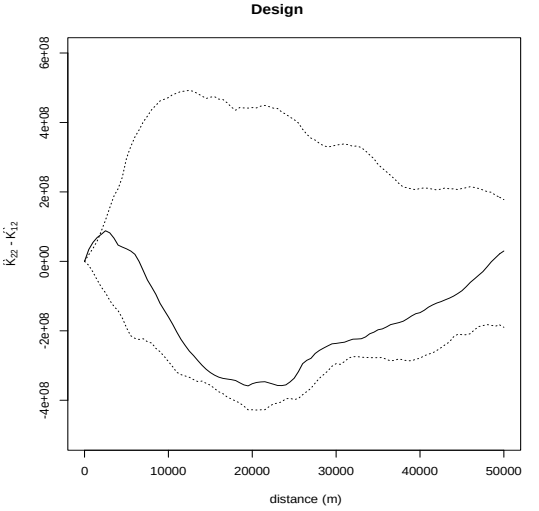
a


Architecture
$\hat{K}_{11} - \hat{K}_{12}$
2e+09
1e+09
0e+00
-1e+09
-2e+09
0
10000
20000
30000
40000
50000
distance (m)

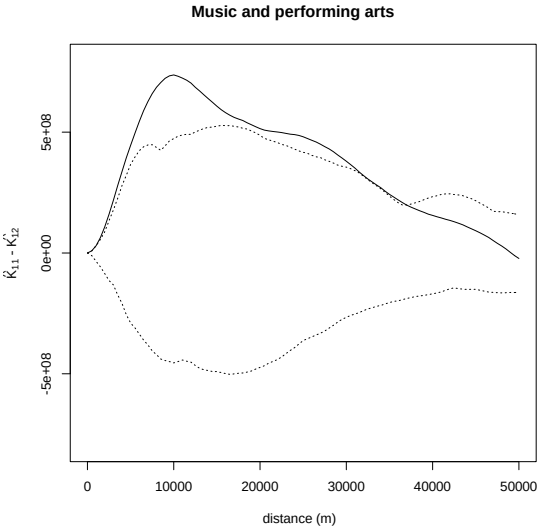

Architecture
$\hat{K}_{22} - \hat{K}_{12}$
2e+09
1e+09
0e+00
-1e+09
-2e+09
0
10000
20000
30000
40000
50000
distance (m)

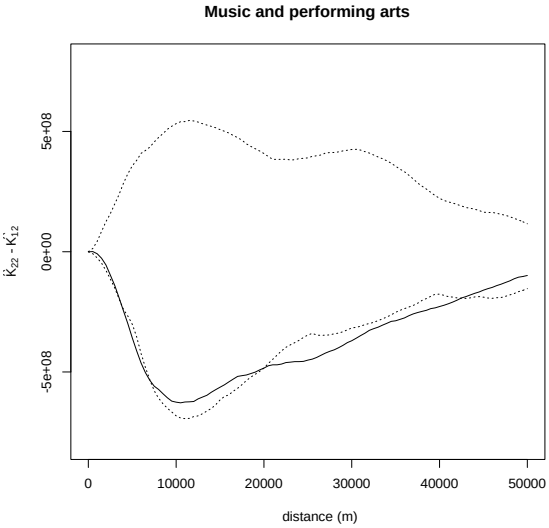
b


Design
$\hat{K}_{11} - \hat{K}_{12}$
6e+08
4e+08
2e+08
0e+00
-2e+08
-4e+08
-6e+08
0
10000
20000
30000
40000
50000
distance (m)

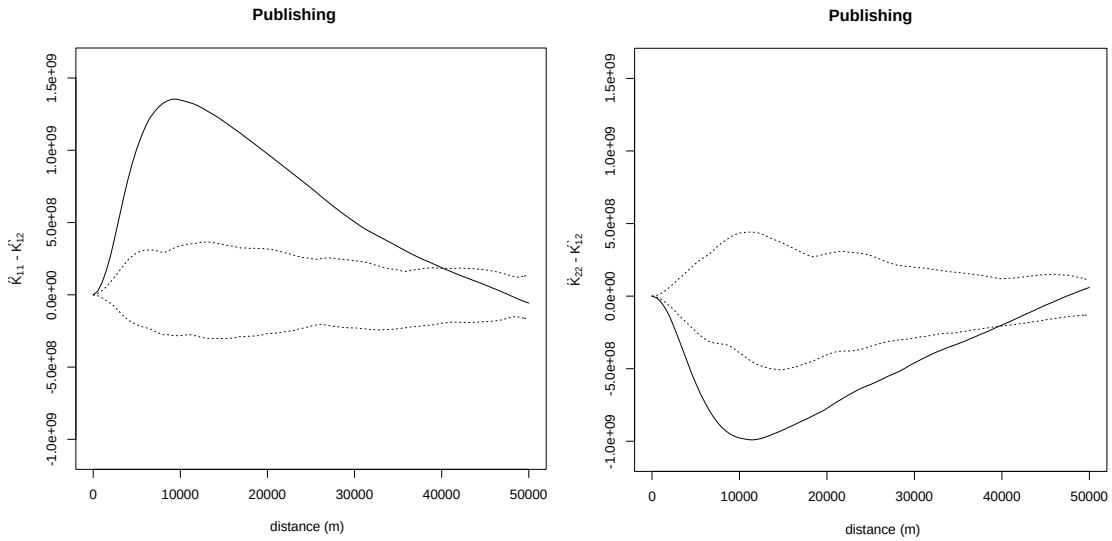

Design
$\hat{K}_{22} - \hat{K}_{12}$
6e+08
4e+08
2e+08
0e+00
-2e+08
-4e+08
0
10000
20000
30000
40000
50000
distance (m)

c

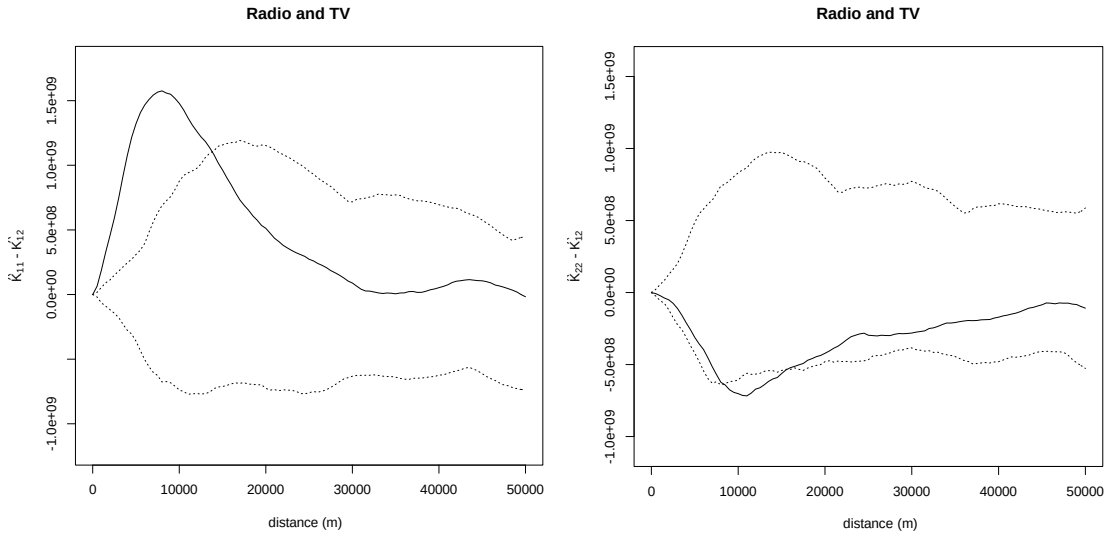

Music and performing arts
$\hat{K}_{11} - \hat{K}_{12}$
5e+08
0e+00
-5e+08
0
10000
20000
30000
40000
50000
distance (m)


Music and performing arts
$\hat{K}_{22} - \hat{K}_{12}$
5e+08
0e+00
-5e+08
0
10000
20000
30000
40000
50000
distance (m)

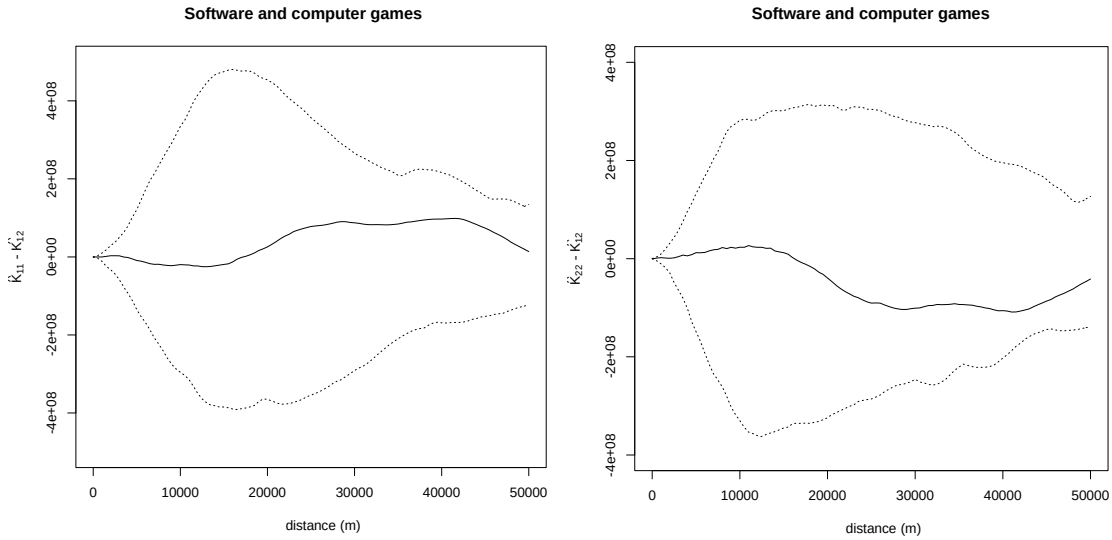
d


Publishing
Publishing
$\hat{K}_{11} - \hat{K}_{12}$
$\hat{K}_{22} - \hat{K}_{12}$
1.5e+09
1.0e+09
5.0e+08
0.0e+00
-5.0e+08
-1.0e+09
0
10000
20000
30000
40000
50000
distance (m)

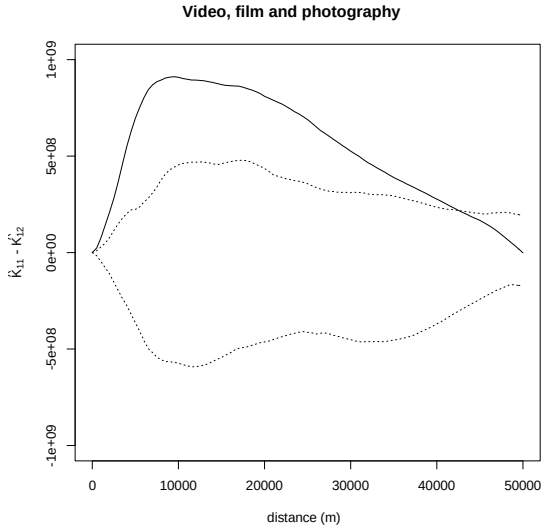
e

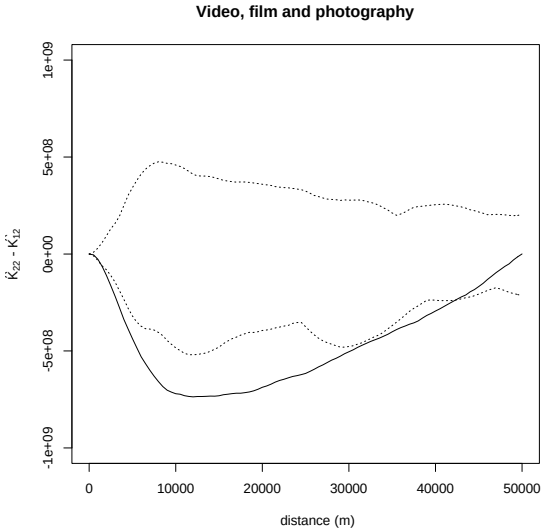

Radio and TV
Radio and TV
$\hat{K}_{11} - \hat{K}_{12}$
$\hat{K}_{22} - \hat{K}_{12}$
1.5e+09
1.0e+09
5.0e+08
0.0e+00
-5.0e+08
-1.0e+09
0
10000
20000
30000
40000
50000
distance (m)

f


Software and computer games
Software and computer games
$\hat{K}_{11} - \hat{K}_{12}$
$\hat{K}_{22} - \hat{K}_{12}$
4e+08
2e+08
0e+00
-2e+08
-4e+08
0
10000
20000
30000
40000
50000
distance (m)

g


Video, film and photography
1e+09
5e+08
0e+00
-5e+08
-1e+09
0
10000
20000
30000
40000
50000
distance (m)


Video, film and photography
1e+09
5e+08
0e+00
-5e+08
-1e+09
0
10000
20000
30000
40000
50000
distance (m)

h