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Spatial Distribution of Economic Activities in Local Labour Market Areas: The Case of Italy

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Abstract

The agglomeration of industries has recently received much interest both in empirical and theoretical works. Several studies investigated the spatial distribution of economic activities in Western Europe using various measures of geographical concentration. The fundamental problem with the indices currently used in the literature is that they do not take explicitly into account the spatial structure of the data, and as a result the same degree of concentration is compatible with very different localization schemes. In the present work we present an analysis which combines the information provided by the standard measure of concentration of Ellison and Glaeser together with the measure of spatial autocorrelation introduced by Moran. Data on employment and plant size for the years 1991 and 2001 are used to identify sectoral location patterns in Italy in the manufacturing industry and service sectors.

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1. Introduction

Economists and geographers have recently devoted an increasing interest in the analysis of the spatial distribution of economic activities with a special attention towards agglomeration phenomena. Researchers and policy makers have been particularly fascinated by the observation that the actions of one firm may have advantages in production and innovation activities for all firms in the cluster. Moreover, agglomeration economies have been proven to play a significant role in the analysis of regional development, regional growth and industrial location. The concept of agglomeration economies implies that a spatial concentration of economic activity generates positive effects on the productivity of the firms located in the area.

There is a substantial literature on geographic concentration of industry and agglomeration economies building on Marshall (1890). The geographic concentration of production may arise from different sources and may involve firms belonging to the same industry as well as firms from different sectors. Firms in the same industry benefit by being in close proximity to one another. These benefits are generated in three main ways. First, geographical proximity increases communication, facilitating technological spillovers between firms within the same industry. Second, the formation of industrial districts can induce efficient provision of intermediate inputs to firms in greater variety and at lower cost due to the growth of subsidiary trades. Third, firms can share larger markets for inputs and outputs and in particular they can share a local skilled labour pool. The forces described above are also referred to as localization economies. They imply that firms benefit from clustering with other firms in the same sector, although those forces remain external to them. The concentration of high-tech industry in the Silicon Valley and the automobile industry in Detroit are two successful examples of agglomeration of firms in a single industry (Ellison and Glaeser, 1997).

However, in many cases, we observe clusters of firms belonging to different industries. This tendency has been often observed at the level of urban agglomeration. Major cities tend to be characterized by a large concentration of heterogeneous economic activities. Most of them are services. Unlike localization economies, which emerge as the number of firms in the same industry in a certain area increases, urbanization economies are a function of city size. They are not related to the size of the individual firm or the industry cluster. The sources of urbanization economies are quite diverse. A well functioning infrastructure of transportation (including roads, airport and cargo facilities) and communication offer transfer savings for firms. Moreover, the proximity of markets and easy access to specialized services (such as financial, legal or accountancy services) facilitate the operations of firms and enable them to allocate their resources more effectively without having to provide all required services on their own. Besides, the proximity of a great number of economic agents from different fields provides better possibilities for face-to-face interaction.

Despite the considerable theoretical advances made in this field of economics, empirical research is somehow scarce. Notable exceptions are studies on the geographical dispersion in the manufacturing sector in the US (Ellison and Glaeser, 1997; Kim, 1995, 1999; Hanson, 1998).

In the EU, the process of economic integration has led to drastic changes in the industrial structure of its Member States. Midelfart *et al.* (2004) have largely discussed the changes that have occurred in Europe in recent decades. Looking at the manufacturing sector, a number of industries that were largely sparse in the early 1980s have become more and more concentrated. These are mostly low-skilled labour intensive industries which are moving their production to the peripheral low-wages regions. On the opposite, a significant clustering has occurred in a number of medium and high-tech industries that tend to concentrate in those regions where the offer of high-skilled workers is richer. Considering the service sector the authors find evidence of a generalized high level of dispersion in the EU with a tendency of the poorer countries to catch up with the richer ones in terms of amount of services offered. In a recent study, Brülhart and Traeger (2005) use entropy indices to describe sectoral location patterns across Western European regions over the 1975–2000 period. Employing bootstrap inference to test the statistical significance of changes in observed concentration measures, they conclude that the geographic concentration of aggregate employment has not changed significantly over the period under analysis.¹

Remarkably, in Europe, few studies consider spatial concentration within a country, and so far rather little is known about geographic concentration of sectors at sub-national level and across the full range of economic activities. Maurel and Sedillot (1999) offer an empirical investigation of the geographic concentration of French industries and compare the observed level of concentration to that of the US. Together with traditional industries, they find that some high-technology industries are strongly localized in France, which supports the view that technological spillovers may be an important issue. The identification of the most and least localized industries reveals similar patterns in France and the US. The existence of a major geographic concentration in a number of high-tech industries and those industries linked to the provision of natural resource (i.e. extractive industries) - as well as traditional industries - is observed in Spain by Alonso-Villar *et al.* (2004). The study shows also that the higher the technological level of the industry, the higher the agglomeration it experiences. Braunerhjelm and Johansson (2003) examine the spatial concentration of Swedish production in the manufacturing and service industries. They observe that large differences prevail in the geographical concentration of production across sectors, and that these increased over time. Whereas manufacturing has become more concentrated over time and employ less people, the service sector displays an opposite pattern characterized by employment growth and lower concentration. In spite of what has been observed in other countries (i.e. France and Spain above mentioned) there are no signs that in Sweden knowledge-intensive industries are more spatially concentrated than others.

So far, the majority of the empirical studies have focused on the manufacturing industries, with a special attention towards innovative and high-tech industries. A growing empirical literature has established that the spatial concentration of manufacturing activity enhances productivity and growth (Ciccone, 2002). In this context, innovative industries play a central role. As observed in Gordon and

¹ For a comprehensive survey of studies of geographic concentration patterns in Europe see Combes and Overman (2004).

McCann (2005), the growing interest towards innovative firms has been fostered by the strong performance recorded in the last century in a number of industrial clusters characterized by the presence of small and medium sized innovative firms able to maintain high standard of productivity and to be highly competitive. The distribution of innovative activities in Europe has been largely analyzed in Moreno, Paci and Usai (2005), Maggioni (2002) and Braschi (1998). The question whether high-technology industries tend to concentrate in Germany is addressed in Alecke et al (2006). Despite the large effort made by the German governments to promote the creation of high-tech industrial clusters, the authors find no support for the existence of a relationship between agglomeration and high-technology related business among German manufacturing industries.

In Italy, there is a tendency in the literature to investigate the distribution of industrial activities by looking in the majority of the cases at the manufacturing sector, leaving outside the analyses the services (Lafourcade and Mion, 2005, Pellegrini, 2003 and Pagnini, 2003 among others).

This study takes a rather different angle. We seek to analyze the extent of geographic concentration of Italian industries between 1991 and 2001, making use of a large dataset containing employment data for 23 manufacturing industries and 17 service sectors. The analysis will be pursued stepwise. First, we will examine the pattern of geographical concentration, emphasizing the differences between the manufacturing and service industries, by calculating Ellison and Glaeser concentration index for each sector in our database. Second, we extend the analytical framework and we consider agglomeration among industries, which means we explicitly account for spatial dependence that may occur among geographical units. As a final step, we provide a unified picture of the way firms locate in Italy, by combining the information provided by the measure of concentration of Ellison and Glaeser and the proposed measure of agglomeration based on the Moran's I statistics of spatial autocorrelation.

Rather than on administrative geographical units, the study will focus on functional areas. Large administrative units are not satisfactory for two major reasons: on one hand, administrative boundaries are usually the result of historical, political, economical and social events and they may no longer represent the present extension of factor and product markets; on the other, the dimension of growth possess a peculiar role at a local level, as for example in the case of Italy, where clusters and polarisation happen in areas that are smaller than provinces.

The paper is structured as follows. Section 2 reviews the measures of geographical concentration currently used in the literature. Section 3 presents the data used and gives some initial descriptive features. Section 4 illustrates the model of Ellison and Glaeser and applies the proposed index to assess the concentration of manufacturing and service industries in Italy. Section 4 extends the analysis to account for spatial dependence. Section 5 provides the main conclusions.

2. Measuring the Geographical Concentration of Economic Activities

To assess the geographic distribution of economic activities, researchers have traditionally used concentration indices such as those defined by Herfindahl (1950), Gini (1912), and Ellison and Glaeser (1997).² The question whether or not an industry is concentrated can be addressed using different measures of activity, typically employment or production. In the following discussion we will refer to employment.

In the case of a single industry the Herfindahl index is defined as the sum of the region's squared shares, with the shares obtained as the number of employees in region i divided by the number of the employees in all regions. If we consider a territory divided into n areas indexed by i , the Herfindahl index is equal to $H = \sum_{i=1}^n z_i^2$. The resulting measure lies in the interval $[1/n; 1]$. If all the activities are located in the same area, the index reaches its maximum value of 1. Conversely, if there is perfect distribution of activities in the territory, the index takes the minimum value of $1/n$. The advantage is that the index is easy to compute, but only assesses spatial concentration, because it does not consider the distribution in the territory of all activities. In other words, it does not compare a sector of activity's concentration to that of other sectors, but to spatial homogeneity over the whole study area.

The location Gini index fills this gap. Proposed by Krugman (1991) as a measure for assessing the spatial distribution of activities, it is nowadays the most frequently used index for measuring the spatial concentration of economic activities (Brühlhart and Torstensson, 1996; Audretsch and Feldman 1996; and Amati, 1999). The coefficient is constructed as follows. For every region i the ratio of the share of total employment in all sectors of activity is calculated. Then the ratios are ranked and they are used to derive a Lorentz curve in which the vertical axis indicates the region's cumulative share of the total employment in sector s and the horizontal axis indicates the region's cumulative shares of employment in all sectors of activity (in the considered region). The area between the resulting curve and the 45-degree line is the so-called location Gini coefficient. In the case of a perfectly homogeneous distribution the quantity is equal to zero (the Lorentz curve and the bisector coincide). At the other extreme, the more the distribution of sector s is concentrated, the further the location curve is located from the 45-degree line, and the closer the Gini coefficient is to its maximum value of 1 (or 0.5 depending on the scale). A major drawback related to the use of the Gini index lies in its insensitivity to economies of scale due to the fact that it does not take into account the size of a firm. Furthermore, as pointed out by Arbia (2001a and 2001b) the measure is totally insensitive to the relative position of the regions in space.

² In the literature these indices are in some cases classified as cluster-based methods to distinguish them from the approaches based on distance-based methods. Cluster-based methods consider the space as discrete and measure the spatial concentration of specific industries according to pre-defined geographical units (i.e. administrative boundaries). On the contrary, distance-based methods consider the space as continuous and investigate the existence of spatial patterns in the distribution of economic activities by observing single plants as they were points distributed over the space (see Duranton and Overman, 2005 and Marcon and Puech, 2003 for an application of distance-based methods to the study of industrial concentration in the UK and France respectively).

The index proposed by Ellison and Glaeser (1997) settles the first of the two problems mentioned above, considering both the number of employees within the industries and the size of the plants. The measure controls for differences in the size distribution of plants and for differences in the size of the geographic units. An important characteristic of the index is that it is based on a rigorous statistical model of location choice in which the industries decide about their locations by looking at the existence of natural advantages in the area and the spillover effects rising from being located close to other plants. Taking a similar dartboard approach, Maurel and Sédillot (1999) and Devereux *et al.* (2004) develop alternative indices of localisation with the same properties.

Unfortunately, traditional measures of concentration only assess the degree to which industries distribute over a number of areas without considering the relative position of the regions in the space and the spatial dependence among territorial units. As a result, the same degree of concentration is compatible with very different localization schemes. Alternatively, as proposed in Arbia (2001b), one can derive a composite index in which both a-spatial measures of concentration and spatial measures - able to discriminate between geographical patterns - are simultaneously considered. There are few empirical works that explicitly consider the relative position of the regions in the space. Midelfart-Knarvik *et al.* (2004) propose an index of *spatial separation* that takes into account distances between locations. The proposed measure is defined as $SP^k \equiv C \sum_i \sum_j (s_i^k s_j^k \delta_{ij})$ where δ_{ij} is a measure of the distance between the two locations i and j , s_i^k and s_j^k are the shares of industry k in location i and j respectively, and C is a constant. The interpretation of the index is therefore a production weighted sum of all the bilateral distances between locations. Lafourcade and Mion (2005) quantify the degree of spatial agglomeration in the Italian manufacturing industries using a measure of spatial agglomeration where proximity is expressed in terms of minimum road distances among pair of locations. Results show that while large plants exhibit a clear tendency to cluster within narrow geographical units such as local labour systems, small establishments, by contrast, rather co-locate within wider areas in which a distance-based pattern emerges.

3. Description of the data

The computation of the concentration measures relies on a large dataset containing data on the number of employees and the number of plants in Italy for the years 1991 and 2001. The data refers to 24 manufacturing sectors (including building) and 17 service sectors at 2-digit NACE level. The Italian National Statistical Office (ISTAT) conducts on regular intervals - every ten years - census survey on the industry and the service sectors. The dataset gives detailed geographic (around 8100 Italian municipalities) and industrial (up to 3-digit NACE) information on location and employment of the universe of Italian plants. Starting from the municipality level, we further aggregate them in larger administrative units (in the specific NUTS3 and NUTS2 regions) and in functional regions (local labour market areas, or LLMAs).

Without going in-depth in defining what a NUTS regions is, we prefer to focus on the concept of functional areas and its implications for the economic analyses.³ The OECD (2002, p.11) defines a functional region as “a territorial unit resulting from the organisation of social and economic relations in that its boundaries do not reflect geographical particularities or historical events. It is thus a functional sub-division of territories”. The LLMA are suitable for several applications both for study and for operational purposes.

There is a long tradition of regionalization exercises based upon labour market variables. Most OECD Member countries, either on an official or a semi-official basis, have defined or delineated functional regions in terms of local labour markets. Even though there are slight differences in the definitions used, the ratio underlying the delineation of such regions remains the same and it is based on the same principle of commuting conditions.

In Italy the concept of functional region has been translated into practice with the identification of a large number of Local Labour Systems (in Italian *Sisemi Locali del Lavoro*). The Local Labour Systems (LLS) are aggregations of two or more contiguous municipalities identified on the basis of the self-containment of the daily commuting flows between the place of residence and the place of work. In practice, an area can be considered a local labour system in the moment in which there is evidence of a concentration of residential activities (such as most individual and family consumption), of work activities (such as expenses for production and distribution) as well as those social relations that are created between these two poles. The central role of the LLS has been recently recognized by the European Commission. Following a period of negotiation between the European Authorities and the Italian Government the LLS have become the territorial units used by the EU to identify the areas eligible under the Objective 2 in the Northern and Central regions of Italy for the 2000-2006 programming period (Commission Decision 2000/530/EC of the 27 July 2000).

The adoption of the LLMA as analysis units represents a strong innovation and introduces the possibility of a complete geographic representation of economic and social phenomena. Analysis of economic data by local labour system allows to shed light on some important aspects of Italian industrialisation and on the main structural changes, with reference to the territorial concentration of the various manufacturing industries as well as of the services. Large administrative units (such as regions and provinces) are not satisfactory for two major reasons: on one hand, administrative boundaries are usually the result of historical political, economic and social events and they may no longer represent the present extension of factor and product markets; on the other, the dimension of growth takes a specific relevance at a local level, as for example in the case of Italy, where clusters and polarisation happen in areas that are smaller than provinces.

³ The Nomenclature of Territorial Units for Statistics (NUTS) has been established by Eurostat at the beginning of the 1970's in order to provide a single uniform breakdown of territorial units for the production of regional statistics. The hierarchy subdivides each Member State into a whole number of regions at NUTS-1 level. Each of these is then subdivided into smaller regions at NUTS-2 level, and these in turn into smaller areas at NUTS-3 level. In Italy the regions at NUTS2 and NUTS3 level correspond respectively to *regions* and *provinces*.

The ISTAT updates the number of the LLS every ten years. The 955 local systems originally defined in Italy in 1981 were reduced to 784 in 1991 and further to 686 in 2001. This reduction was, among others factors, the result of infrastructure improvements and increase in private cars with the subsequent increase in the daily distances covered by the workers to reach their place of activity. As LLSs diminished in number between 1981 and 2001, the average surface area of the new LLSs increased accordingly. Table 1 illustrates the number of LLS in Italy in 1991 and 2001. A remarkable features that emerges is that the drop has been larger in the northern and southern part of the country, while in the central and insular regions it has been rather small.

Macro-region	1991	2001	Variation
North-West	140	114	-26
North-East	143	119	-24
Centre	136	128	-8
South	237	203	-34
Islands	128	122	-6
Italy	784	686	-98

Table 1. LLS in 1991 and 2001 and distribution across macro-regions

Figure 1 illustrates the spatial distribution of the employment in the manufacturing sector in 1991 and 2001. We observe a picture which goes beyond the traditional dichotomy between the Northern and the Southern regions of the country. Although a clear spatial pattern emerges, in which the majority of the workforce is concentrated in the Northern part of the country, we find a certain dynamism in the employment of some of the Southern regions in the period 1991-2001. The positive result is not representative for the whole South, but has to do with the good performance of specific sectors like the *leather and footwear* in some of the industrial clusters located in the regions Campania and Puglia (the industrial districts of Solofra and Barletta) and the *iron and steel* industry in the area of Taranto.

Service sectors in Europe are generally less geographically concentrated than manufacturing sectors with a definite pattern of increasing concentration of services in the leading cities (Brüllhart and Trager, 2005). A close look at the map in Figure 2 reveal a strong tendency of the service industries to locate in the proximity of the major cities (i.e. Turin, Rome, Milan, and Florence). A strong presence of services is also observable in the traditional “industrial triangle” formed by the three cities of Milan, Turin and Genoa. In order to improve their productivity in the core business, large manufacturing plants have recently moved some auxiliary activities to external service firms (Paci and Usai, 2005). As a consequence a large number of activities offering different services like marketing, accounting, cleaning, security have started to operate in areas that in the past were traditionally devoted to the manufacturing.

Figure 1: number of employees (000) in the manufacturing sector in the LLS

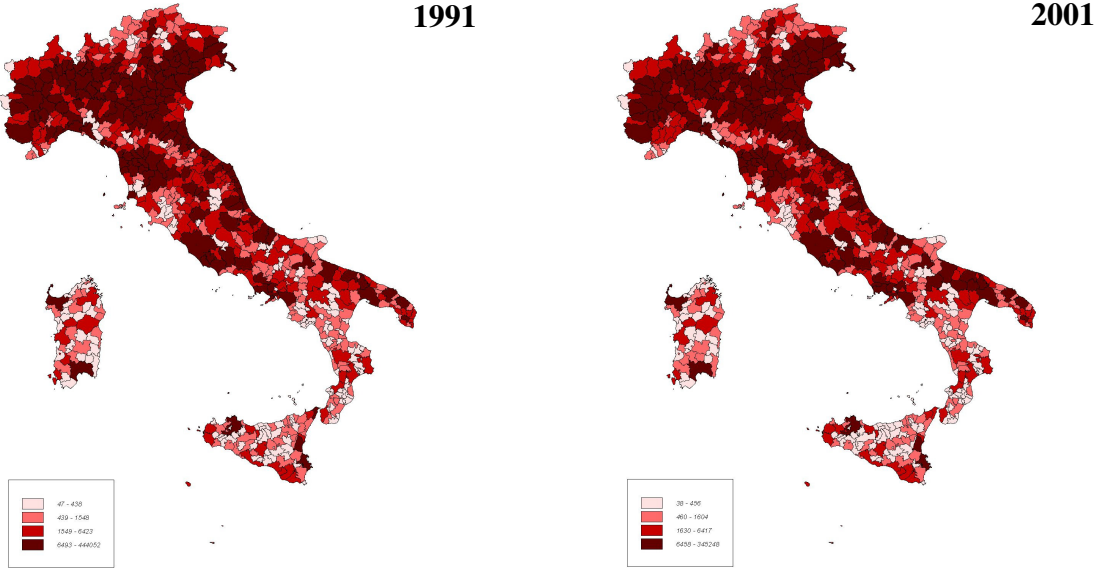
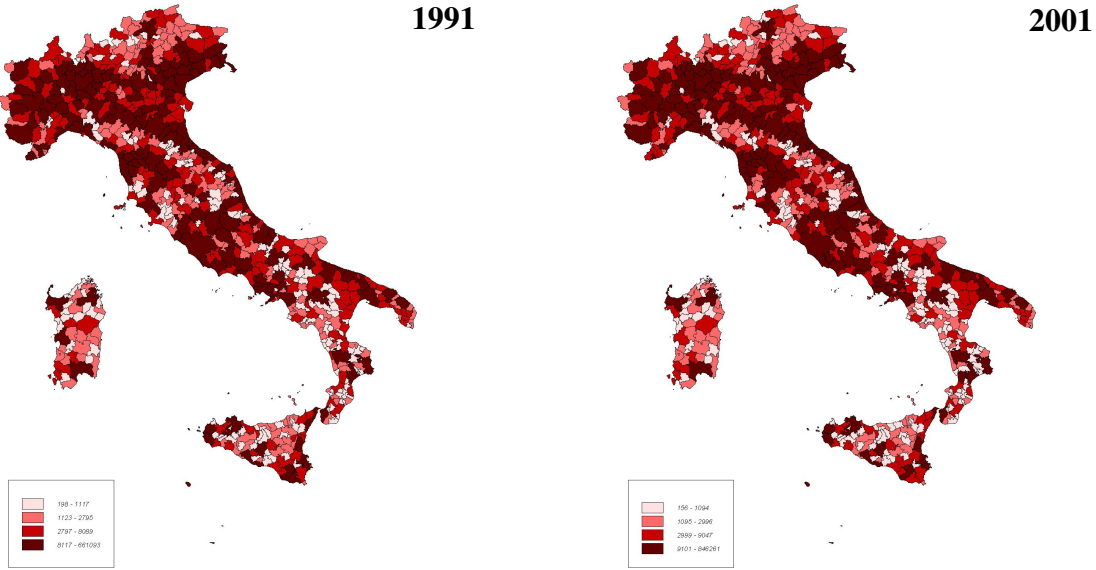


Figure 2: number of employees (000) in the service sector in the LLS



4. Geographic concentration of economic activities in Italy: the Ellison and Glaeser index.

To measure the extent to which an industry is geographically concentrated we follow the approach of Ellison and Glaeser (1997). The authors propose an index of geographic concentration derived from a model of location choice in which localized industry-specific spillovers, natural advantages and random chance all contribute to determine the degree of geographic concentration within an industry. The

proposed index is then used to test whether levels of concentration observed across territorial units are greater than it would be expected to arise randomly as if “the plants had chosen locations by throwing darts on a map” (Ellison and Glaeser, 1997).⁴ This measure captures the agglomeration effects due to the natural endowments of the area, the spillovers effects existing among pairs of plants and a combination of the two. The advantages of the method are twofold. On one hand, the approach builds on a rigorous statistical model in which a situation of random distribution of economic activities across the areas is taken as a benchmark. On the other hand, the index is able to correct for the fact that in industries consisting of few relatively large plants, industry concentration may appear to be higher than it is in reality. For a country like Italy, where the industrial structure is characterized by a small number of large plants (i.e. FIAT in Turin) and a large number of firms of small and medium size, a measure able to give the correct weight to this two extreme cases turns out to be very useful.

In the case of a single industry, the point of departure is a “raw measure” of geographic concentration $G = \sum_{i=1}^N (s_i - x_i)^2$, where s_1, s_2, \dots, s_N are the share of an industry’s employment in each of the N geographic areas, x_1, x_2, \dots, x_N are the share of total employment in those areas. Assuming that firms choose their location as if dartboards were thrown at a map, EG show how the expected value of G is related to the parameters characterizing their model, namely the strength of natural advantages and spillovers, γ , and the industry’s plant size distribution. They show that under these assumption the expected value of G is:

$$E(G) = \left(1 - \sum_{i=1}^N x_i^2\right) (\gamma(1 - \gamma)H) \quad (4.1)$$

where $\gamma = \gamma^{na} + \gamma^s - \gamma^{na}\gamma^s$ is a combined measure controlling for the strength of natural advantages, spillovers and a combination of the two, and $H = \sum_{j=1}^M z_j^2$ is the Herfindahl index of plants’ size distribution calculated over $j = 1, \dots, M$ plants. Rearranging the expression in (4.1) for γ , they propose the following statistics as an estimator of γ denoted by $\hat{\gamma}_{EG}$:⁵

$$\hat{\gamma}_{EG} \equiv \frac{G - \left(1 - \sum_{i=1}^N x_i^2\right) H}{\left(1 - \sum_{i=1}^N x_i^2\right) (1 - H)} \equiv \frac{\sum_{i=1}^N (s_i - x_i)^2 \left(1 - \sum_{i=1}^N x_i^2\right) \sum_{j=1}^M z_j^2}{\left(1 - \sum_{i=1}^N x_i^2\right) \left(1 - \sum_{j=1}^M z_j^2\right)} \quad (4.2)$$

Ellison and Glaeser show that the expected value of this measure is zero if plants are randomly located, with any positive value of the index interpreted as localization. In particular, values between 0 and 0.02 are

⁴ Ellison and Glaeser (1997), p. 890

⁵ For details of the derivation of the expression in (3.1), see Ellison and Glaeser (1997).

interpreted as weak localization, and anything above 0.05 as a strong tendency to localize (Ellison and Glaeser 1997). Testing the statistical significance of the index indicates whether a sector's distribution of activity across locations is significantly concentrated or dispersed.⁶

The proposed index has three desirable properties: [i] It takes on the value of zero not if employment is uniformly spread across space (as is the case in most of the traditional indicators) “[...] ... but instead if employment is only as concentrated as it would be expected to be had if the plants in the industry chosen locations by throwing darts at a map”; [ii] the index is comparable across industries in which the size distribution of firms differs; [iii] it allows meaningful comparisons regardless of differences in the level of geographic aggregation at which employment data for the respective industries are available (Ellison and Glaeser 1997: p. 890 and p. 900).

However, this approach is not without limits. The first limit is due to the nature of the parameter γ . As recognized by the same authors “An analysis of the mean concentration of industries will allow one only to estimate $\gamma = \gamma^m + \gamma^s - \gamma^m \gamma^s$, and any estimate $\hat{\gamma}_{EG} \in [0,1]$ is compatible with a pure natural advantage model, a pure spillover model, or a combination of the two” (Ellison and Glaeser, 1997, p.897). It follows that the index is not able to distinguish between the various forces that may drive agglomeration. Whether agglomeration is mainly caused by natural advantages or by spillovers among plants, the measure treats the two situations as identical. To overcome this problem Alecke et al. (2006) propose to relate in a regression analysis the degree of the agglomeration to agglomeration forces. Leaving outside the analyses those factors linked to natural advantages, they investigate three types of forces that may measure agglomeration externalities: [i] a pooled market for specialized input services (input sharing), [ii] a pooled market for specialized labour and [iii] knowledge spillovers.

Second, and perhaps the most severe weakness of this approach is that the model behind the index is inherently a-spatial. Every region is treated as an isolated island, and its relative position on the map is not taken into account. This is a similar critique as the one discussed in Arbia (2001a) against most of the indices of geographic concentration currently used in the literature. In the presents work we explicitly address the problem and we seek to interpret jointly the information provided by the E-G and a measure of agglomeration that considers the interaction among regions.

In the following we analyze the geographical concentration in the manufacturing and service sectors in Italy for the years 1991 and 2001. Both functional areas and administrative regions are considered. Contrary to most of the previous study investigating the geographical concentration of

⁶ As shown in Ellison and Glaeser (1997) and Maurel and Sedillot (1999), the variance of the estimator under the null hypothesis of no-spillovers ($\gamma = 0$) is given by:

$$\text{var}(\hat{\gamma}_{EG}) = \frac{2(1-H)^2}{\left(1 - \sum_{i=1}^M x_i^2\right)} H^2 \left(\sum_{i=1}^M x_i^2 - 2 \sum_{i=1}^M x_i^3 + \left(\sum_{i=1}^M x_i^2\right)^2 \right) - \sum_{j=1}^N x_j^4 \left(\sum_{i=1}^M x_i^2 - 4 \sum_{i=1}^M x_i^3 + 3 \left(\sum_{i=1}^M x_i^2\right)^2 \right)$$

The result can be used to perform a *t*-test comparing the value of the index with twice its standard deviation, which, under the assumption of normality, is a test at the 5% confidence level. Significant values of the test indicate that the observed degree of concentration deviates significantly from a situation of random location of the firms.

economic activities (Ellison and Glaeser, 1997 and Maurel and Sedillot, 1999 among others) there is no problem of withheld data in our sample. The only problem is that – excluding the case of the industries that employ one or two workers – the Herfindahl measure of plants’ size had to be recovered from the size-class groups to where the data were allocated (the first class indicating firms employing from three to five workers, the second class indicating firms employing from six to nine workers and so on, for a total of 11 classes).⁷

4.1 The concentration of 2-digits manufacturing and service industries in Italy

We computed the index $\hat{\gamma}_{EG}$ for each of the 2-digits manufacturing and service industries in the database.⁸ Previous studies have observed that the scale of the territorial units may influence the degree to which industries appear to be concentrated (Ellison and Glaeser, 1997; Maurel and Sedillot, 1999; Lafourcade and Mion, 2005; Alecke et al., 2006). To address this question we considered three different geographic partitions corresponding to functional areas (LLS), provinces (NUTS3), and regions (NUTS2). In about 95% of the industries the observed positive value of the index is statistically significant at 95% confidence level.

Table 2 illustrates the average value of γ_{EG} in the manufacturing and service sectors for the years 1991 and 2001. The results show that there is a strong tendency of the index to increase together with the level of the territorial unit. A reason for this may be spatial autocorrelation between local labour systems which the index is not able to capture at the lower geographical level because of its “a-spatial” property discussed above. Thus, computing the Ellison and Glaeser index at a higher degree of spatial aggregation will partly internalize positive spatial autocorrelation, leading to a higher concentration.

	LLS		NUTS3		NUTS2	
	1991	2001	1991	2001	1991	2001
manufacturing	0.024	0.015	0.027	0.023	0.042	0.041
service	0.018	0.024	0.018	0.037	0.020	0.034
all sectors	0.022	0.020	0.024	0.029	0.033	0.038

Table 2. Average values of γ_{EG} in 1991 and 2001 at different levels of spatial aggregation.

As a first observation, we note that whereas non-service industries, such as manufacturing, have been spreading out, most service activities have become increasingly clustered. The different behaviour of manufacturing and service sectors is consistent with a number of different explanations. One candidate is falling transport costs. Due to their non-tradable nature, services have traditionally spread out. The drop in

⁷ The plants’ size Herfindahl index has been obtained following the procedure suggested in Schmalensee (1977). The author proposes a set of measures that can be used to approximate the Herfindahl index when data are allocated within size-classes. Among all measures proposed by the author we opted for the MINL specification.

⁸ See Appendix A for a detailed table reporting the values of the index for all sectors.

transport costs is now allowing them to agglomerate. Manufacturing, however, already became highly concentrated during the last centuries (Kim, 1995; Glaeser, 1998); the more recent fall in transport costs has been weakening the benefits from agglomeration, leading manufacturing activity to spread out. The different concentration patterns across manufacturing and service sectors may also be due to technological change. Carlini (1985), for instance, argues that the splitting up of the production process into different stages has allowed manufacturing firms to relocate certain activities to less dense areas. As for the rising concentration of services in cities, high-tech services are experiencing an increasing need to be close to specialized workers. Service-sector activity concentrates in large cities because large home markets make it possible to both economize on the cost of moving people and to achieve economies of scale.

Moreover, while in 1991 the concentration in the service sector is lower than in the manufacturing sector for all three levels of spatial aggregation, a contrary pattern is revealed in the 2001. In 2001, only across the largest NUTS2 regions we observe a higher level of concentration in the manufacturing than in the service. For a number of reasons mentioned above, service industries tend to locate in urban areas. The NUTS2 regions are somehow too large to capture agglomeration effects occurring at a lower scale.

The geographical concentration of the 15 most localized 2-digit industries across LLS is now discussed. Table 3 and Table 4 list the results. As an initial step, we are interested in analyzing how industrial agglomeration has evolved throughout the period. Among the 15 most localized industries, only the *tobacco industry* and the *manufacturing of non-metal products* are not among the most concentrated industries in both years. For the remaining, the same industries appear to be among the most concentrated both in 1991 and in 2001. The stability in agglomeration level observed in most Italian industries is a pattern common among other countries (Dumais *et al.*, 2002 for the US, Devereux *et al.*, 2004 for the UK and Alonso-Villar *et al.*, 2004 for Spain). As expected, one of the most concentrated industries is the *manufacturing of motor vehicles*, although in 2001 the degree of concentration has noticeably declined. The result is not surprising, considering that the larger part of the production of motor vehicles in Italy is carried by one single firm (the FIAT) that concentrates its activity in a small number of plants (i.e. Turin in Piemonte, Termini Imerese in Sicily and Melfi in Basilicata).⁹

Considering the sectors with the highest level of concentration, we can identify two distinct groups of industries, both groups characterized by the large presence of firms of small and medium size. The first group includes a number of high-tech industries as *manufacture of office machinery and computers*, *manufacture of chemicals*, *manufacture of radio, television, and communication*. As pointed in Maggioni (2002) Italian high-tech clusters are somehow different from the one existing in other countries. In general, they are composed by small and medium sized firms that are characterized by a lower level of technology adoption. In a second group, we can include traditional activities in which the weight of small and medium-sized enterprises is also very high, such as *manufacture of textile* and *tanning and dressing of leather*. These are industries which operate in a well defined area of the country, the so-called “Third Italy”. The

⁹ However, in the last years, thanks to the financial and fiscal incentives available to the Objective 1 regions, the FIAT has decentralized part of its production in the southern regions of Italy.

concept of the Third Italy started to be used in the late 1970s. At that time, it became apparent that while little economic progress was in sight in the South (Second Italy), and the traditionally rich Northwest (First Italy) was facing a deep crisis, in contrast the Northeast and centre of Italy showed fast growth which attracted the attention of social scientists.

2-digit	sector	T-I	K-I	E-G
34	Manufacture of motor vehicles, trailers...	medium-high		0.1447
30	Manufacture of office machinery and computers	high		0.1314
61	Water transport		yes	0.0868
66	Insurance and pension funding, except compulsory...		yes	0.0629
73	Research and development	high	yes	0.0467
24	Manufacture of chemicals and chemical products	medium-high		0.0336
32	Manufacture of radio, television and communication	high		0.0291
17	Manufacture of textiles	low		0.0285
22	Publishing, printing and reproduction of recorded...	low		0.0264
19	Tanning and dressing of leather	low		0.0264
72	Computer and related activities	high	yes	0.0160
27	Manufacture of basic metals	medium-low		0.0150
23	Manufacture of coke, refined petroleum products...	medium-low		0.0137
36	Manufacture of furniture; manufacturing n.e.c.	medium-low		0.0133
35	Manufacture of other transport equipment	medium-high		0.0129

T-I: technological intensity classification: OECD); K-I: knowledge intensive (source: EUROSTAT)

Table 3. 15 most concentrated industries in 1991 in the LLS

2-digit	sector	T-I	K-I	E-G
66	Insurance and pension funding, except compulsory...		yes	0.0726
61	Water transport		yes	0.0723
34	Manufacture of motor vehicles, trailers...	medium-high		0.0614
17	Manufacture of textiles	low		0.0343
19	Tanning and dressing of leather	low		0.0335
24	Manufacture of chemicals and chemical products	medium-high		0.0283
73	Research and development	high	yes	0.0263
72	Computer and related activities	high	yes	0.0215
32	Manufacture of radio, television and communication	high		0.0214
22	Publishing, printing and reproduction of recorded...	low		0.0164
27	Manufacture of basic metals	medium-low		0.0162
16	Manufacture of tobacco products	low		0.0159
36	Manufacture of furniture; manufacturing n.e.c.	medium-low		0.0156
26	Manufacture of other non-metallic mineral products	medium-low		0.0152
35	Manufacture of other transport equipment	medium-high		0.0140

T-I: technological intensity classification: OECD); K-I: knowledge intensive (source: EUROSTAT)

Table 4. 15 most concentrated industries in 2001 in the LLS

In a number of sectors where small firms predominated, groups of firms, clustered together in specific regions, seemed to be able to grow rapidly, develop niches in export markets and offer new employment opportunities.

Among the service industries, *Research and Development*, *Computer and Related Activities* and *Insurance and Pension Funding* show the highest level of concentration. Different from manufacturing, these industries tend to concentrate in dense urban areas, where a pool of high-qualified workers is available, and where the high costs associated to the services offered may be divided among a higher number of potential customer.

5. When concentration meets agglomeration: Spatial patterns in the distribution of economic activities in Italy

The concentration index employed so far provides information about the extent to which each industry in Italy is concentrated in a number of areas, but does not take into consideration whether those areas are close together or far apart. Two industries may appear equally geographically concentrated, while one is located in two neighbouring regions, and the other splits between the northern and the southern part of the country. The index of Ellison and Glaeser, as well most of the measures of geographical concentration used in the empirical literature to characterise spatial concentration of economic activities, is inherently a-spatial in that it is totally insensitive to the relative position of the regions in the space. These indicators actually measure the degree of variability of the distribution of employment across observations for a given partition of the space, a feature that in the literature has been in some cases refer to as concentration (Arbia, 2001b; Lafourcade and Mion, 2005).

However, if we consider the fact that regions are not isolated island, we may be interested in a measure of spatial agglomeration which takes into account spatial dependence - and hence spatial autocorrelation - among geographical units. Spatial autocorrelation occurs when values of a variable observed at nearby locations are more similar than those observed at locations more distant from each other. More precisely, positive spatial autocorrelation occurs when high or low values of a variable tend to cluster together in space and negative spatial autocorrelation when high values are surrounded by low values and *vice-versa*. A number of formal statistics have been developed to measure spatial autocorrelation. Among such indicators, in the present work we will rely on the one introduced by Moran (Moran, 1950).

Before proceeding with our analysis, in what follows we show how by looking at concentration or agglomeration separately one may draw an erroneous picture of the location patterns of the Italian industries. Borrowing a simple example illustrated in Arbia (2001b), let us consider in Figure 3 three hypothetical situations in which 9 firms locate in an area exhaustively divided into 9 sub-regions. It is evident that the degree of spatial agglomeration is much higher in case (a) than in case (c); however, standard measures of geographical concentration (i.e. Ellison and Glaeser or the Gini location quotient)

fails in distinguishing between them. As a conclusion, the same degree of concentration will be associated to the three situations.¹⁰ This problem has been recently addressed in Midelfart et al. (2004) and Lafourcade and Mion (2005).

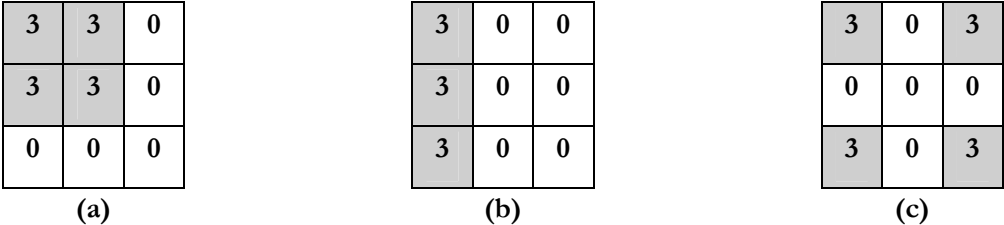


Figure 3. Extreme cases of agglomeration of 12 firms distributed across 16 regions. From left to right spatial agglomeration decreases. In the specific, (a) high spatial agglomeration, (b) intermediate spatial agglomeration, (c) low spatial agglomeration.

Alternatively, one may consider the relative positions of the regions in space and include spatial dependence in the analytical framework. The literature has provided a number of indicators to distinguish amongst various cases of agglomerations, like the Getis and Ord statistics of local spatial association (Getis and Ord, 1992) or the Moran’s *I* index of spatial autocorrelation (Moran, 1950), the latter being the one we actually use in this paper. However, a spatial correlation coefficient alone is not a good measure of spatial concentration. It is more devoted to identify spatial patterns in the distribution of the variable under analysis, while a good concentration measure should be paying attention to the variability in the distribution across space. Whether an equal numbers of firms are located as in Figure 4.a or in Figure 4.b, the Moran’s *I* remains unchanged, although it is evident that the level of dispersion in Figure 4.b is much higher than in Figure 4.a.



Figure 4. Localization scheme with the same degree of spatial agglomeration as measured by the Moran’s *I* statistics and different levels of geographic concentration (in terms of variability)

Given the preceding discussion, it is therefore interesting to consider jointly both coefficients, since they are complementary to each other (Arbia, 2001b). Both are measures of the localization of industries across areas, but the Ellison and Glaeser index focuses more on the relative distribution pattern among observations while the Moran’s *I* focus more on the spatial pattern of this distribution.

¹⁰ Arbia (2001b) shows that Locational Gini calculated over a situation similar to the one illustrated in Figure 3 produce the same value.

In what follows we propose a measure of spatial agglomeration that considers explicitly the relative position of the areas in the space. The point of departure is the simple and commonly used measure of regional industrial concentration given by the Location Quotient (LQ) as defined in Kim (1995):¹¹

$$LQ_{s,i} = \frac{e_{s,i} / \sum_i e_{s,i}}{\sum_s e_{s,i} / \sum_i \sum_s e_{s,i}} \quad (5.1)$$

where the numerator measures the share of employment in sector s in region i with respect to the total employment in Italy in sector s , and the denominator is the share of total employment in region r with respect to the total employment in Italy.

The Moran's I coefficients of spatial autocorrelation are then obtained by using the Location Quotient relative to each sector and each location as the basis for computations. To allow comparisons between different regions the Moran's I coefficients are expressed in standardized scores. The statistic compares the value of a continuous variable at any location with the value of the same variable at surrounding locations. Formally, for each variable of interest, the Moran's I is:

$$I = \frac{N}{\sum_{i=1}^n \sum_{j=1}^n w_{ij}} \frac{\sum_{i=1}^n \sum_{j=1}^n w_{ij} (x_i - \bar{x})(x_j - \bar{x})}{\sum_{i=1}^n (x_i - \bar{x})^2} \quad (5.2)$$

where N is the sum of observations, w_{ij} is the element in the spatial weight matrix corresponding to the observation pair i, j (with $i \neq j$), x_i and x_j are the observed values of the location quotient as defined in expression (5.1) for the locations i and j (with mean \bar{x}), and the first term is a scaling constant. The former is the traditional approach to spatial autocorrelation, in which the overall pattern of dependence is summarized into a single indicator. Values of I larger than the expected value $E(I) = -1/(n-1)$ indicate positive spatial autocorrelation and *vice-versa*. To allow comparisons between different regions the Moran's I coefficients are expressed in standardized scores.

A crucial issue in the definition of spatial autocorrelation is the notion of "location similarity", or the determination of those locations for which the values of the variable are correlated. This is formally expressed in a spatial weight matrix (Cressie, 1991; Anselin, 1988). A spatial weight matrix is a N by N

¹¹ Moreover, the Location Quotient is usually adopted by the Italian Statistical Office as a measure of geographic concentration in its official reports.

positive and symmetric matrix W with generic elements w_{ij} . More formally, $w_{ij} = 1$ when i and j are neighbours and $w_{ij} = 0$ otherwise¹²

The nature of the spatial interaction may be defined in several ways, such as simple contiguity (i.e. common border), distance contiguity, inverse distance (to account for distance-decay effects). Both these weights are closely linked to the physical feature of the spatial units on a map. When the spatial interaction is determined by factors linked to economical variables, authors have proposed the use of weights with a more direct relation to the particular phenomenon under study (i.e. travel time, social or economical distances)¹³. In the following of the paper we will employ a weight matrix defined by a first order contiguity $w_{ij} \in \mathbf{W}$ are the elements of a binary contiguity matrix usually employed in spatial statistics and econometrics such that $w_{ij} = 1$ if region i and j are neighbours and $w_{ij} = 0$ otherwise.¹⁴

In what follows we restrict our comments to the results for the LLS. A close look at the table in Appendix B reveal that about 90% of industries in Italy are significantly spatially autocorrelated. Five sectors are not significantly spatially autocorrelated at the 10% level: *manufacturing of coke*, *manufacturing of chemicals products*, *air transport*, *research and development* and *insurance and funding*. This means that globally for these industries there is no tendency of agglomeration of similar values in nearby areas. However, this evidence does not preclude that high peaks of employment may be located in specific areas. In support of this affirmation we recall that all sectors above mentioned were highly concentrated when in the previous section we have considered only the results produced by the Ellison and Glaeser index. One other interesting episode of industrial localization is given by the *Manufacture of motor vehicles* industry. According to the ranking given by the Ellison and Glaeser index, concentration within this sector is among the highest in Italy. However, when we consider explicitly spatial dependence this sector shows a very low level of spatial agglomeration.

The Moran's I statistics of the 15 more agglomerated industries in 1991 and 2001 are listed in Table 5 and Table 6. A first remarkable feature is that over the years, with the exception of few sectors, the 15 highest positions in the rank have been occupied by the same industries. A feature that is very similar to what we found before for the most concentrated industries.

Considering the manufacturing, a first observation is that agglomeration patterns tend to emerge in traditional sectors characterized by a lower level of technology adoption like *tanning of dressing and leather*, *manufacture of textile*, and *manufacture of metal products*. Traditionally, these are sectors in which operate firms of small and medium size localized in well defined industrial clusters in the northern-central part of the country (Emilia Romagna and Marche). However, we observe that the spatial pattern in these sector tend

¹² By convention, the diagonal elements of the weight matrix are set to zero.

¹³ It is important to consider that the standard estimation and testing approaches assume the weight matrix to be exogenous. Therefore, indicators for the socioeconomic weights should be chosen with great care to ensure the exogeneity, unless their endogeneity is considered explicitly in the model specification (Anselin and Bera, 1998).

¹⁴ Spatial agglomeration indices for Italian manufacturing industries have been computed in Lafourcade and Mion (2005) using a spatial weight matrix based on travel time distances among pair of locations. The authors report that the results were very similar to the one obtained through a definition of proximity based on a first order contiguity matrix we use in our analyses.

to be stronger at the lower level of LLS than - for instance - at the level of NUTS3 regions (see Appendix B).

2-digit	sector	T-I	K-I	<i>I</i>
52	Other wholesale			0.526
55	Hotels and restaurants			0.499
19	Tanning and dressing of leather	low		0.489
29	Manufacture of machinery and equipment n.e.c.	medium-high		0.418
18	Manufacture of wearing apparel; dressing and dyeing.	low		0.408
70	Real estate activities		yes	0.391
45	Construction			0.381
28	Manufacture of fabricated metal products, except...	medium-low		0.355
50	Sale, maintenance and repair of motor vehicles...			0.303
17	Manufacture of textiles	low		0.261
36	Manufacture of furniture; manufacturing n.e.c.	medium-low		0.254
51	Wholesale trade and commission trade, except of...			0.230
33	Manufacture of medical, precision and optical...	high		0.224
31	Manufacture of electrical machinery and apparatus...	medium-high		0.196
72	Computer and related activities	high	yes	0.184

T-I: technological intensity (classification: OECD); K-I: knowledge intensive (source: EUROSTAT)

Table 5. 15 most agglomerated industries in 1991 in the LLS

2-digit	sector	T-I	K-I	<i>I</i>
70	Real estate activities		yes	0.619
52	Other wholesale			0.540
19	Tanning and dressing of leather	low		0.463
55	Hotels and restaurants			0.448
29	Manufacture of machinery and equipment n.e.c.	medium-high		0.396
28	Manufacture of fabricated metal products, except...	medium-low		0.352
18	Manufacture of wearing apparel; dressing and dyeing..	low		0.341
51	Wholesale trade and commission trade, except of motor...			0.317
50	Sale, maintenance and repair of motor vehicles...			0.304
36	Manufacture of furniture; manufacturing n.e.c.	medium-low		0.260
33	Manufacture of medical, precision and optical...	high		0.256
71	Renting of machinery and equipment without operator		yes	0.255
67	Activities auxiliary to financial intermediation		yes	0.239
72	Computer and related activities	high	yes	0.206
17	Manufacture of textiles	low		0.205

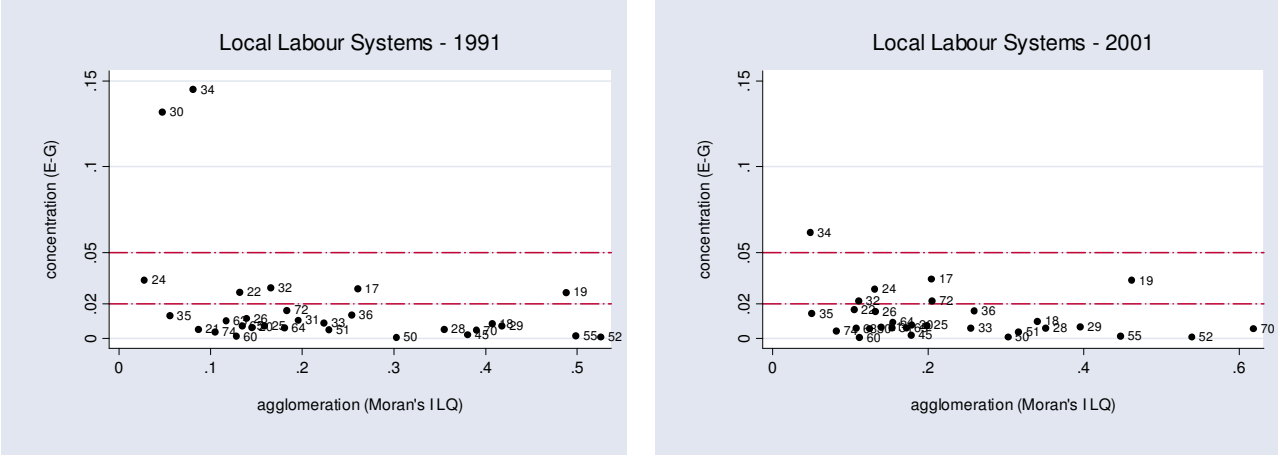
T-I: technological intensity (classification: OECD); K-I: knowledge intensive (source: EUROSTAT)

Table 6. 15 most agglomerated industries in 2001 in the LLS

The preceding discussion showed that the degree of concentration varies across sectors and that a same degree of concentration is compatible with different values of spatial autocorrelation, as indicated by

Moran's I statistic. Figure 5 displays the scatterplot of the Ellison and Glaeser measure of geographic concentration against the Moran's I index of spatial agglomeration.

Figure 5. When agglomeration meets concentration.



The two dash lines correspond to the values proposed by Ellison and Glaeser for indicating low concentration (below 0.02), medium concentration (between 0.02 and 0.05) and high concentration (above 0.05). The area of the scatterplot may be then virtually divided into four quadrants:

- top-left: medium-high concentration vs. low agglomeration
- top-right: medium-high concentration vs. high agglomeration
- bottom-right: low concentration vs. high agglomeration
- bottom-left: low concentration vs. low agglomeration

There are three sectors that in 1991 concentrate their activity in a small number of areas which are not close to each other. For these sectors we observe a high level of geographical concentration accompanied by a low tendency to cluster in space. They are the *manufacturing of motor vehicle* (nr. 34), the *manufacturing of office machinery* (nr.30) and the *manufacturing of chemicals* (nr. 24). The result is not surprising, as these are sectors that traditionally belong to well defined areas (motor vehicle in Turin and the chemicals industry in the region Lazio). However, in 2001 the picture slightly changes, showing a decline in the degree of spatial concentration of the sectors above mentioned. A number of financial and fiscal incentives to promote the economic development of lagging regions in Italy has induced firms to relocate their activity in those areas.

Only two industries *Tanning and Dressing of Leather* (nr.19) and *Manufacture of Textile* (nr.17) are highly concentrated and at the same time strongly agglomerated. The result depends mostly on the fact that in Italy there is a long tradition of industries in these sectors in a well defined administrative areas - Marche for the leather industry and Toscana for the textile - where the majority of the production is located in a number of contiguous industrial districts. The picture is similar in both years, highlighting the fact that these are episodes of industrial success with a strong territorial linkage far from being transitory, a

feature that reinforces the central role played by the industrial districts in Italy on promoting economic development and high standard of productivity.

In the bottom-right area of the scatterplot are industries for which the distribution of employment is rather spread over the country, although similar values tend to cluster together. We focus on the three extreme cases, *Other Wholesale* (nr.52), *Hotels and Restaurants* (nr.55), and *Real Estate Activities* (nr.70). A common factor is that all of them are services, in particular they are activities with a low level of knowledge intensity. The interpretation of the results in the bottom-left quadrant are less immediate. We find here a large number of very different industries in which either agglomeration nor concentration seems to emerge.

6. Conclusions

This paper analyzes the spatial distribution of economic activities in Italian economy using an ample dataset on industrial employment in the manufacturing and service sectors. In our analyses we distinguish between geographical concentration and spatial agglomeration and we develop an approach that considers simultaneously both concepts when analyzing the spatial distribution of industries in the study area. Geographical concentration and spatial agglomeration may be viewed as the two sides of the wider notion of localization. Both of them look at the distribution of economic activities across a number of areas, but while concentration focuses more on the variability of the distribution, agglomeration is devoted to identify spatial patterns of similar values in this distribution. Although concentration has been largely studied in the literature, only few studies have considered agglomeration (Lefourcade and Mion, 2005; Guillaín and Le Gallo, 2006). We have measured concentration by mean of the index proposed by Ellison and Glaeser (1997). This measure has been preferred over others because it allows to test the statistical significance of the observed degree of concentration. Over the whole economy, we found that in almost 95% of Italian industries a clear and significant concentration pattern emerges. Moreover, we have observed that large differences prevail in the geographical concentration of production across sectors. In particular, concentration has substantially declined in the manufacturing industry while, on the opposite, service industries are becoming more and more concentrated. In the manufacturing sector, the industries that show up as being the most concentrated are those belonging to the traditional sectors and high-tech industries. Among the service industries, *Research and Development* and *Insurance and Pension Funding* show the highest level of concentration. However, the results provided by the Ellison and Glaeser index do not consider the spatial nature of the data and the relative position of the areas in the space. Hence, we define a measure of agglomeration that explicitly considers proximities among observations and thus their spatial dependence. We start from a Location Quotient which measures the concentration of the production in each sector and in each location in Italy and then we use this measures as the basis for computing a Moran's I statistic of spatial autocorrelation. Where the Moran's I is positive and significant we conclude that the industry is agglomerated. Our results show that about 90% of industries in Italy tends to

agglomerate, with a prevalence of manufacturing industries characterized by a low level of technology. Among services, *hotels and restaurants* and *other wholesale* are the most agglomerated.

However, we observe that in some cases concentration and agglomeration produce very different pictures. For instance, there are situations where an industry is highly concentrated but only relatively agglomerated, or *vice-versa*. An analysis that is based only on one of the two definitions of localizations may bring researchers to erroneous conclusions. Therefore, we have analyzed four hypothetical situations of industrial localization which may arise if we look at concentration and agglomeration together. We find that concentration may go hand by hand together with agglomeration. Highly specialized industrial districts in well defined regions in Italy are a good example (i.e. textile industry in Toscana). On the contrary, those industries in which internal economies of scale may be achieved only by increasing their size tend to be highly concentrated but only moderately agglomerated (i.e. motor vehicle industry and the chemical industry). In these industries economies of scale are generated because a large level of investment takes place at one single location rather than across a range of different locations (McCann, 2001).

For the future, there are a number of issues which may deserve attention. First, it may be interesting to study distribution of economic activities in Italy at a lower level of sectoral aggregation. For some sectors it has been found that a finer level of desegregation is more suitable to detect episodes of industrial clustering (Lefourcade and Mion., 2005). Another interesting topic is about the forces which may induce a sector to concentrate rather than agglomerate, whether these are similar or very different in the two facets of localisation. A specific analysis devoted to identifying which are actually the determinants that relate to concentration, which to agglomeration and whether they have some of them in common may give an important contribution to the study of the localisation patterns in the Italian industry.

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Appendix A

Ellison and Glaeser index

Note: significant values of the statistics in bold

		1991	2001	1991	2001	1991	2001
15	Manufacture of food products and beverages	0.0037	0.0048	0.0050	0.0067	0.0072	0.0165
16	Manufacture of tobacco products	0.0025	0.0159	0.0304	0.0561	0.0720	0.1368
17	Manufacture of textiles	0.0285	0.0343	0.0281	0.0328	0.0550	0.0513
18	Manufacture of wearing apparel; dressing and dyeing...	0.0081	0.0096	0.0121	0.0137	0.0231	0.0393
19	Tanning and dressing of leather	0.0264	0.0335	0.0368	0.0471	0.0894	0.1431
20	Manufacture of wood and of products of wood...	0.0060	0.0076	0.0067	0.0101	0.0065	0.0219
21	Manufacture of pulp, paper and paper products	0.0050	0.0061	0.0066	0.0102	0.0140	0.0175
22	Publishing, printing and reproduction of recorded media	0.0264	0.0164	0.0261	0.0169	0.0285	0.0099
23	Manufacture of coke, refined petroleum products...	0.0137	0.0071	0.0142	0.0216	0.0410	0.0548
24	Manufacture of chemicals and chemical products	0.0336	0.0283	0.0359	0.0331	0.0487	0.0377
25	Manufacture of rubber and plastic products	0.0069	0.0071	0.0113	0.0116	0.0406	0.0291
26	Manufacture of other non-metallic mineral products	0.0112	0.0152	0.0106	0.0151	0.0152	0.0344
27	Manufacture of basic metals	0.0150	0.0162	0.0238	0.0295	0.0356	0.0349
28	Manufacture of fabricated metal products, except...	0.0049	0.0056	0.0075	0.0083	0.0248	0.0188
29	Manufacture of machinery and equipment n.e.c.	0.0069	0.0063	0.0108	0.0101	0.0397	0.0332
30	Manufacture of office machinery and computers	0.1314	0.0053	0.1231	0.0399	0.1171	0.0224
31	Manufacture of electrical machinery and apparatus n.e.c.	0.0102	0.0058	0.0136	0.0093	0.0336	0.0212
32	Manufacture of radio, television and communication...	0.0291	0.0214	0.0302	0.0252	0.0253	0.0102
33	Manufacture of medical, precision and optical...	0.0086	0.0056	0.0127	0.0156	0.0200	0.0242
34	Manufacture of motor vehicles, trailers...	0.1447	0.0614	0.1495	0.0803	0.1781	0.0973
35	Manufacture of other transport equipment	0.0129	0.0140	0.0180	0.0201	0.0145	0.0292
36	Manufacture of furniture; manufacturing n.e.c.	0.0133	0.0156	0.0129	0.0171	0.0301	0.0476
37	Recycling	na	na	na	na	na	na
45	Construction	0.0018	0.0015	0.0020	0.0040	0.0009	0.0054

Ellison and Glaeser index (continued)

2-digit id	sector	SLL		NUTS3		NUTS2	
		1991	2001	1991	2001	1991	2001
50	Sale, maintenance and repair of motor vehicles...	0.0003	0.0005	0.0004	0.0016	0.0014	0.0071
51	Wholesale trade and commission trade, except of motor...	0.0047	0.0033	0.0046	0.0009	0.0051	0.0031
52	Other wholesale	0.0005	0.0006	0.0009	0.0037	0.0031	0.0082
55	Hotels and restaurants	0.0012	0.0009	0.0024	0.0008	0.0048	0.0038
60	Land transport; transport via pipelines	0.0008	0.0001	0.0012	0.0002	0.0037	0.0092
61	Water transport	0.0868	0.0723	0.0926	0.0017	0.1257	0.0059
62	Air transport	na	na	na	na	na	na
63	Supporting and auxiliary transport activities; activities...	0.0100	0.0055	0.0100	0.1090	0.0083	0.3784
64	Post and telecommunications	0.0057	0.0092	0.0058	0.3679	0.0103	0.0023
65	Financial intermediation, except insurance and pension...	0.0069	0.0058	0.0063	0.0061	0.0045	0.0113
66	Insurance and pension funding, except compulsory...	0.0629	0.0726	0.0574	0.0093	0.0308	0.0012
67	Activities auxiliary to financial intermediation	na	na	na	na	na	na
70	Real estate activities	0.0044	0.0053	0.0056	0.0059	0.0160	0.0009
71	Renting of machinery and equipment without operator	na	na	na	na	na	na
72	Computer and related activities	0.0160	0.0215	0.0155	0.0007	0.0116	0.0050
73	Research and development	0.0467	0.0263	0.0478	0.0057	0.0489	0.0065
74	Other business activities	0.0034	0.0039	0.0028	0.0068	0.0014	0.0314
average value (41 sectors)		0.022	0.015	0.024	0.029	0.033	0.038

Appendix B – Detailed tables

Moran's *I* statistics of Spatial autocorrelation (variable: regional Location Quotient)

Note: significant values of the statistics in bold

2-digit id	sector name	Moran's I (LQ)				Moran's I if above (+) or below (-) t		
		SLL		NUTS3		SLL		NUT
		1991	2001	1991	2001	1991	2001	1991
15	Manufacture of food products and beverages	0.171	0.147	0.093	0.103	-	-	-
16	Manufacture of tobacco products	0.124	0.128	0.025	-0.008	-	-	-
17	Manufacture of textiles	0.261	0.205	0.122	0.096	+	+	-
18	Manufacture of wearing apparel; dressing...	0.408	0.341	0.371	0.360	+	+	+
19	Tanning and dressing of leather; manufacture...	0.489	0.463	0.288	0.270	+	+	+
20	Manufacture of wood and of products of wood...	0.146	0.180	0.307	0.348	-	-	+
21	Manufacture of pulp, paper and paper products	0.087	0.140	0.172	0.210	-	-	-
22	Publishing, printing and reproduction of recorded..	0.132	0.106	0.246	0.216	-	-	+
23	Manufacture of coke, refined petroleum products..	0.013	-0.007	-0.003	0.009	-	-	-
24	Manufacture of chemicals and chemical products	0.028	0.132	0.092	0.264	-	-	-
25	Manufacture of rubber and plastic products	0.159	0.199	0.311	0.266	-	+	+
26	Manufacture of other non-metallic mineral...	0.140	0.133	0.187	0.133	-	-	-
27	Manufacture of basic metals	0.156	0.166	-0.020	-0.019	-	-	-
28	Manufacture of fabricated metal products, except..	0.355	0.352	0.365	0.340	+	+	+
29	Manufacture of machinery and equipment n.e.c.	0.418	0.396	0.546	0.564	+	+	+
30	Manufacture of office machinery and computers	0.048	0.126	0.109	0.088	-	-	-
31	Manufacture of electrical machinery and apparatus.	0.196	0.154	0.334	0.313	+	-	+
32	Manufacture of radio, television and...	0.166	0.111	0.204	0.138	-	-	+
33	Manufacture of medical, precision and optical...	0.224	0.256	0.078	0.044	+	+	-
34	Manufacture of motor vehicles, trailers and...	0.082	0.049	0.164	0.159	-	-	-
35	Manufacture of other transport equipment	0.056	0.051	0.067	0.104	-	-	-
36	Manufacture of furniture; manufacturing n.e.c.	0.254	0.260	0.341	0.280	+	+	+
37	Recycling	0.056	0.114	0.089	-0.034	-	-	-
45	Construction	0.381	0.179	0.200	0.108	+	-	-

Moran's I statistics of Spatial autocorrelation (continued)

2-digit id	sector	SLL		NUTS3		SLL		NUT
		1991	2001	1991	2001	1991	2001	1991
51	Wholesale trade and commission trade, except of...	0.230	0.317	0.397	0.312	+	+	+
52	Other wholesale	0.526	0.540	0.634	0.547	+	+	+
55	Hotels and restaurants	0.499	0.448	0.203	0.181	+	+	-
60	Land transport; transport via pipelines	0.129	0.112	0.169	0.099	-	-	-
61	Water transport	0.074	0.071	0.046	0.010	-	-	-
62	Air transport	-0.010	-0.012	-0.038	-0.043	-	-	-
63	Supporting and auxiliary transport activities...	0.117	0.108	0.191	0.195	-	-	-
64	Post and telecommunications	0.181	0.155	0.374	0.299	-	-	+
65	Financial intermediation, except insurance and...	0.135	0.173	0.133	0.152	-	-	-
66	Insurance and pension funding, except...	-0.011	-0.006	-0.082	-0.035	-	-	-
67	Activities auxiliary to financial intermediation	0.114	0.239	0.353	0.508	-	+	+
70	Real estate activities	0.391	0.619	0.727	0.797	+	+	+
71	Renting of machinery and equipment without...	0.138	0.255	0.054	0.110	-	+	-
72	Computer and related activities	0.184	0.206	0.094	0.095	-	+	-
73	Research and development	0.010	0.028	-0.048	-0.117	-	-	-
74	Other business activities	0.105	0.083	0.018	0.106	-	-	-
average value (41 sectors)		0.184	0.193	0.198	0.189			

APPENDIX C

Statistical Classification of Economic Activities in the European Community, NACE Rev. 1.1

T-I: technological intensity. OECD classification

K-I: knowledge intensive. EUROSTAT classification

2-digit	Manufacturing (including Building)	T-I	K-I
15	Manufacture of food products and beverages	low	
16	Manufacture of tobacco products	low	
17	Manufacture of textiles	low	
18	Manufacture of wearing apparel; dressing and dyeing...	low	
19	Tanning and dressing of leather	low	
20	Manufacture of wood and of products of wood...	low	
21	Manufacture of pulp, paper and paper products	low	
22	Publishing, printing and reproduction of recorded media	low	
23	Manufacture of coke, refined petroleum products...	medium-low	
24	Manufacture of chemicals and chemical products	medium-high	
25	Manufacture of rubber and plastic products	medium-low	
26	Manufacture of other non-metallic mineral products	medium-low	
27	Manufacture of basic metals	medium-low	
28	Manufacture of fabricated metal products, except...	medium-low	
29	Manufacture of machinery and equipment n.e.c.	medium-high	
30	Manufacture of office machinery and computers	high	
31	Manufacture of electrical machinery and apparatus n.e.c.	medium-high	
32	Manufacture of radio, television and communication...	high	
33	Manufacture of medical, precision and optical...	high	
34	Manufacture of motor vehicles, trailers...	medium-high	
35	Manufacture of other transport equipment	medium-high	
36	Manufacture of furniture; manufacturing n.e.c.	medium-low	
37	Recycling	-	
45	Building	-	

2-digit	Service	T-I	K-I
50	Sale, maintenance and repair of motor vehicles...		
51	Wholesale trade and commission trade, except of motor...		
52	Other wholesale		
55	Hotels and restaurants		
60	Land transport; transport via pipelines		
61	Water transport		yes
62	Air transport		yes
63	Supporting and auxiliary transport activities; activities...		
64	Post and telecommunications	high	yes
65	Financial intermediation, except insurance and pension...		yes
66	Insurance and pension funding, except compulsory...		yes
67	Activities auxiliary to financial intermediation		yes
70	Real estate activities		yes
71	Renting of machinery and equipment without operator		yes
72	Computer and related activities	high	yes
73	Research and development	high	yes
74	Other business activities		yes