EMERGE Working Paper 13/02

An Exploratory Spatial Data Analysis of Manufacturing Concentration Patterns in Italy

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Abstract

This research aims to increase the academic debate on which indicators and approaches capture more appropriately the phenomenon of economic clustering (see, for instance, Arbia & Piras, 2007). A composite measure is proposed combining discrete and continuous space indicators in order to identify spatial localization more effectively as proposed by several authors such as Arbia (2001), Guillain and Le Gallo (2007), and Sohn (2004). The paper is devoted to unfolding the localization patterns of employment within three-digit manufacturing industries by Italian provinces in 2007 employing the location quotient, the locational Gini, the global Moran's I, and the local indicator of spatial associations since they provide complementary information (see, for instance, Guillain & Le Gallo, 2007). Evidence shows that the manufacture of military fighting vehicles has the highest localization with almost full concentration; whereas the industry of other general-purpose machinery holds the highest global Moran's *I*. Moreover, the five three-digit industries within the two-digit manufacture of machinery and equipment n.e.c. show a relatively high global autocorrelation and concentration. It emerged that these five three-digit medium-high technology intensity industries showed numerous hot-spots clusters in the North of Italy, whereas the South of Italy and Islands were characterized by low-low values associationsa mong Italian provinces in 2007.

JEL Classification: R11, R12, C21

Key words: concentration patterns, discrete-space, autocorrelation, Italy.

1 Introduction

For over a century, geographers and economists have formulated location and agglomeration theories in order to understand and unfold reasons of economic and dwellers' concentration within countries, regions and cities. They have tried to explain why some places grow faster than others generating uneven spatial economic agglomeration. In particular, researchers have aimed to answer "what", "where" and "why" production and commercial activities tend to be concentrated in certain areas over time (Hoover & Giarratani, 1989). In other words, researchers have investigated the reasons for agglomeration formation, what kind of economic activities are concentrated and where they are located. In particular, scholars have focused their attention on pro-concentration and anti-concentration forces in order to explain the motivations of agents' concentration generating balance and imbalance of economic activities among places (Fujita & Thisse, 2002). In order to investigate the mechanism of economic localization, it is paramount to develop suitable indicators to measure the economic externalities generated by agent's proximity. Thus, researchers have developed numerous theoretical and empirical studies to identify and test appropriate indicators to measure intra and inter-industries proximity effects. However, there is little agreement among researchers on which forces play a predominant role in firms and dwellers' localization, and which indicators and approaches capture more appropriately this phenomenon (Arbia & Piras, 2007). Therefore in this paper, a composite measure is proposed combining discrete and continuous space indicators in order to identify spatial clustering more effectively. This approach has been proposed by several authors such as Arbia (2001), Guillain and Le Gallo (2007), and Sohn (2004).

The research is devoted to investigating the employment concentration and autocorrelation of 95 three-digit manufacturing industries by Italian provinces in 2007 using discrete and

continuous-space measures as follows: the locational Gini, the location quotient, the univariate global Moran's *I*, the Moran scatterplots, and the local indicator of spatial association. The combination of these measures provides complementary information in order to detect more accurately spatial clusters (Guillain & Le Gallo, 2007). This paper is divided into five sections. First, the theoretical framework is investigated with particular reference to agglomeration and dispersion forces, and then a methodological approach based on a-spatial and spatial statistics is proposed to detect the geographic concentration patterns of employment. Afterwards, the data collected is described and the empirical results are discussed with reference to discrete concentration and spatial dependency of three-digit manufacturing industries by Italian provinces in 2007. Finally conclusion, limitations and direction for further research are provided.

2 Literature Background

2.1 Economic Agglomeration Forces

Ellison and Glaeser (1999) argue that the presence of competitive natural advantages within a location can explain half of the geography colocalization. Black and Henderson (1998) state that mobility of workers and growth of the city is highly connected to the first nature advantages. Beeson et al. (2001) find that the access to natural communications (i.e. ocean) and produced communications (i.e. railroad), play a paramount role in locational growth as they facilitate trade interconnection to other locations. Ottaviano and Thiesse (2003) argue that the spatial economic inequalities among locations are explainable by first nature and second nature. They assert that natural resources are distributed unevenly among places generating irregular spatial distribution. What is called sometimes the first nature, which is related to natural endowments such as climate, topography, raw materials, communication ways, among other factors. Moreover, Ottaviano and Thiesse (2003) argue that economic

agglomeration asymmetry is not only due to such first nature endowments since many clusters are less natural resources dependent. For instance, Chicago became the central city of the America heartland without any natural competitive advantage (Cronon, 1991). Thus the second nature, which is related to human behaviours, has to be considered in order to explain the formation and development of economic agglomeration. Therefore, pecuniary externalities and technological externalities have to be taken into account in order to fully explain the phenomenon. They can be generated by migratory flow (Krugman, 1991a), input-output linkages (Venables, 1996), diversified (Jacobs, 1969) and specialized (Marshall, 1920) knowledge externalities. The interaction of these forces causes several cumulative effects related to backward linkages (demand side) and forward linkages (cost side) (see, for instance, Fujita & Thisse, 2002; Krugman, 1991b; Puga & Venables, 1998). Therefore, economic externalities are essential in the locational growth and they can be generated by both first nature and second nature. However, agents' concentration accrues factor-market competition and product-market competition (see, for instance, Puga & Venables, 1998), which work against agglomeration forces fostering deindustrialization.

3 Methodology

3.1 Introduction to Spatial Measures

In this section, a composite measure is proposed based on discrete and continuous-space indicators to create synergies between different but complementary measures that are useful to investigate more effectively the colocalization patterns of Italian provinces in 2007. The discrete indices are devoted to identify absolute or relative patterns of concentration. However, they treat the geographic observations as a-spatial without any consideration of the role played by nearby territories. Hence, this may cause an underestimation of agglomeration, in particular if externalities within a location affect its neighbours or vice versa (Guillain &

Le Gallo, 2007). Hence, in order to capture the agglomeration phenomenon more effectively, it is necessary to consider the space as continuous. Therefore, the discrete-space indicators need to be complemented by the continuous-space statistics as proposed by several authors such as Arbia (2001), Sohn (2004), Guillain and Le Gallo (2007). In particular, these latter authors state that the locational Gini coefficients should be combined with the continuous-space indicators as they provide complementary information useful to analyse in-depth the concentration patterns. In the next section, the location quotient (hereafter LQ), the locational Gini coefficient (hereafter Gini), the univariate global Moran's *I* (hereafter Moran's *I*), the Moran scatterplots, and local indicator of spatial associations (hereafter LISA) are illustrated and discussed in order to employ them in the empirical analysis.

3.2 The Spatial Composite Measure

The most popular discrete-space indicator is the locational Gini coefficients (see, for instance, Krugman, 1991a), as it demands limited data and it is easy to compute. The locational Gini coefficient measures the relative sectorial concentration within a location in comparison to the level of the same sector in other locations. There are numerous versions of locational Gini statistics, however in this paper, the Gini's mean difference is employed as proposed by Kim et al. (2000) as follows:

$$Gini_m = \frac{\Delta}{4\bar{\mu}_x} \tag{1}$$

$$\Delta = \frac{1}{n(n-1)} \sum_i \sum_j |x_i - x_j|$$

$$x_{i(j)} = \frac{Province\ i's\ (j's)\ share\ of\ employment\ in\ m}{Province\ i's\ (j's)\ share\ of\ total\ employment} = LQ_{i(j)} \tag{2}$$

$$\bar{\mu}_x = \sum_i \frac{x_i}{n}\ , which\ is\ the\ mean\ of\ x$$

where the provinces are indicated by i and j ($i \neq j$), whereas m and n denote the three-digit manufacturing industries and the number of observations respectively. It is notable that $x_{i(j)}$ is the location quotient ($LQ_{i(j)}$), which measures the locational ratio of employment within a focal region with respect to its total aggregation. This version of Gini can assume values between 0 and 0.5. The former indicates that the distribution of employment is symmetrical between locations, whereas the latter denotes maximum concentration. The locational Gini coefficients is employed in order to unfold the discrete concentration of three-digit manufacturing industries within Italian provinces in 2007. However, the locational Gini coefficients and the location quotient are complemented by the continuous-space indices in order to unfold more effectively clusters of spatial concentration. There are several indicators in the literature to measure such space dependency, however the Moran's I index of spatial autocorrelation (Moran, 1950) and LISA statistics (Anselin, 1995) is employed within this research. They are computed based on the location quotient of employment of three-digit manufacturing industries. In order to allow comparison among different regions the global Moran's I statistics can be written in the standardized form as follows:

$$I_m = \frac{N}{\sum_i \sum_j w_{ij}} \frac{\sum_i \sum_j w_{ij}(x_i - \bar{\mu}_x)(x_j - \bar{\mu}_x)}{\sum_i (x_i - \bar{\mu}_x)^2} \qquad (3)$$

where N is the total observations, $(x_{i(j)} - \bar{\mu}_x)$ is the deviation of $LQ_{i(j)}$with respect to the mean of x. Whereas, w_{ij} is one element of the row-standardized spatial weight matrix (W), which indicates the spatial connection of region i to the region j where $i \neq j$. The queen weight matrix is employed based on the first-order contiguity. The expected value of I_m under the null hypothesis (absence of correlation) is $E(I_m) = -1/(n-1)$. Whereas, $I_m > E(I_m)$ denotes a positive spatial autocorrelation in the employment distribution in the industry m

given by similar values of x_i; whereas $I_m < E(I_m)$ indicates a negative spatial autocorrelation among locations due to dissimilar values of x_i. The Moran's I coefficients lie between $\pm$ 1, where value close to + 1 denotes clustering and near to - 1 indicates dispersion. However, the Moran's I is a global measure and it allows the identification of an overall spatial pattern within a single value. Therefore the Moran scatterplots and the local Moran's I is adopted in order to unfold local spatial pattern relationships. The former allows the classification of 4 different spatial associations: high-low (HL) and low-high (LH) denoting dissimilar values; whereas high-high (HH, hotspot) and low-low (LL, coldspot) indicate similar values of employment between locations. Whereas the latter indicator, the local Moran's I, allows the detection of significant local spatial clusters, local pockets, the influence by the magnitude of the global statistics on the single observation and the identification of significant outliers (see, for instance, Guillain & Le Gallo, 2007). LISA can be also used to test the null hypothesis of absence of local spatial associations, in other words, whether the distribution of values around a specific location deviates from spatial randomness (Anselin, 1995). The local Moran's I can be written (Anselin, 1995) as:

$$I_i = z_i \sum_j w_{ij} z_j \qquad (4)$$

where $z_{i(j)}$ denotes the standardized values in deviations from the mean as $(x_{i(j)} - \bar{\mu}_x)$ with $j \neq i$.

4 Description of Data

The quantitative data has been collected through the Italian National Statistical Office (ISTAT) with regard to the number of employment in economic units disaggregated by 95 three-digit manufacturing industries within 107 Italian provinces in 2007. The industrial classification refers to the statistical classification of economic activities of European

Community (NACE 2007 Rev. 2). This data is used to compute the discrete and continuous-space statistics previously reviewed in order to unfold patterns of employment concentration and spatial autocorrelation of three-digit manufacturing industries among Italians provinces in 2007.

5 Results and Discussions

5.1 Geographic Concentration and Global Autocorrelation of Three-Digit Manufacturing Industries

In this part, the geographic concentration of employment and the global autocorrelation of three-digit manufacturing industries by Italian provinces in 2007 is explored using locational Gini coefficient and the univariate global Moran's *I*. The former allows the detection of disproportional industrial concentration, whereas the latter enables to identify the degree of spatial relationships between a focal province and its neighbouring in terms of location ratio of employment. The combination of these two measures provides complementary information useful for in-depth analysis of spatial patterns (Lafourcade & Mion, 2007). Table one shows the twenty highest Gini coefficients of three-digit manufacturing industries, their relative Moran's *I* statistics, and the five Italian provinces with the highest location quotients of employment for the three-digit manufacturing industries in Italy in 2007.

[Table 1 about here]

The locational Gini displays that the highest industrial concentration was in the manufacture of military fighting vehicles, followed by the manufacture of motor vehicles, the manufacture of magnetic and optical media, the manufacture of man-made fibres, the manufacture of weapons and ammunition, the manufacture of air and spacecraft and related machinery, and the manufacture of batteries and accumulators. These industries hold the Gini coefficients over 0.47 though they have low Moran's *I* coefficients with an exception of the manufacture

of magnetic and optical media with a global autocorrelation of 0.13. Furthermore, it is notable that the industry of manufacture of military fighting vehicles is almost full concentrated with 0.499 where the maximum localization is 0.5. In addition, it is notable that the majority of the twenty industries with high Gini show low autocorrelation with values close to zero in the range between ± 0.05. This can be explained by the fact that some industries are highly concentrated in terms of employment within non-proximity Italian provinces. For instance, the manufacture of military fighting vehicles is almost full localized in La Spezia; the manufacture of motor vehicles is highly concentrated in Potenza, Turin and Chieti; the manufacture of magnetic and optical media in Avellino and Campobasso; the manufacture of man-made fibres has high LQ in Terni, Bergamo and Trento. These provinces are not geographically connected. Whereas several other industries have a relatively high Gini and positive high Moran's *I* coefficients, this means that the employment is relatively concentrated and similar values are detected around contiguous observations. For instance, the manufacture of pesticides and other agrochemical products industry was concentrated in nearby areas such as Ferrara, Ravenna and Bologna in the centre of Italy, and Milan and Cremona in the North; the manufacture of magnetic and optical media was localized in Avellino, Campobasso, Naples, Cosenza, Caserta in the South of Italy in 2007. Furthermore, it is notable that in almost all twenty industries, reported in Table one, show positive coefficients of Moan's *I* with some exceptions such as the manufacture of cement, lime and plaster, the manufacture of games and toys and the manufacture of irradiation, electromedical and electrotherapeutic equipment, among several other industries. The negative Moan's *I* coefficients denote dissimilar values of employment concentration among neigboring provinces. Moreover, Table 2 shows the twenty highest Moran's *I* out of 95 three-digit manufacturing industries, their relative locational Gini, and the five highest locational quotient of employment for each industry in Italy in 2007.

[Table 2 about here]

Table two shows that the manufacture of other general-purpose machinery has the highest Moran's *I* with 0.48, followed by the manufacture of other special-purpose machinery, the sawmilling and planing of wood, the manufacture of metal forming machinery and the machine tools, and manufacture of cutlery, tools and general hardware; with Moran's I coefficient between 0.31 and 0.37. Furthermore, it is notable that the seventeen out of twenty industries with the highest Moran's *I* do not show high concentration with a rank of Gini under the thirtieth position. On the other hand, it emerges that several industries have a relatively high Gini (between 0.44 and 0.42) with relatively high Moran's *I* coefficients (between 0.24 and 0.29) such as the manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations, the manufacture of musical instruments, and the manufacture of optical instruments and photographic equipment.

In this section, the industrial concentration and global autocorrelation of 95 three-digit manufacturing industries has been investigated using locational Gini coefficients and the Moran's *I* statistics in order to unfold the degree of employment localization and its relative global autocorrelation. However, these indicators are global measures as they summarized the concentration and autocorrelation within a single value, hence it does not provide any information about local patterns. Therefore in the following section, the Moran scatterplots and LISA statistics are employed for five selected three-digit manufacturing industries in order to identify significant spatial cluster associations of employment by Italian provinces in 2007.

5.2 Local Spatial Autocorrelation of Three-Digit Selected Industries

The locational Gini and the global Moran's *I* statistics provided complementary information

in order to identify more effectively the spatial distribution of employment. The Gini coefficient denoted concentration and the Moran's *I* indicates autocorrelation, hence their combination helped the detection if a given observation sprawled or is affected by the magnitude of other observations geographically in proximity. However these indices are global as only one measure is computed for each industry, thus they did not give any information about local spatial patterns and geographic dependency. Therefore, the Moran scatterplots and LISA statistics are employed for five selected three-digit industries by Italian provinces in 2007 in order to identify significant local clusters. Table two showed that the five three-digit manufacturing industries within the two-digit industry of manufacture of machinery and equipment n.e.c. (28 digit code of NACE 2007) had a relatively high global Moran's *I* coefficients and a relatively high Gini concentration. Hence, they are further investigated within this section. These five three-digit manufacturing industries refer to the manufacture of other general-purpose machinery, the manufacture of other special-purpose machinery, the manufacture of metal forming machinery and machine tools, the manufacture of agricultural and forestry machinery, and the manufacture of general-purpose machinery. Table three shows the locational Gini, the global Moran's *I* coefficients of those selected industries and their relative four-digit sub-industries.

[Table 3 about here]

Therefore for all five selected industries, the univariate Moran scatterplots and the local Moran's *I* are computed based on the location quotient of employment and the queen weight matrix of first-order contiguity. This allows the detection of four associations of employment patterns: high-high values (HH, hot spots), low-low values (LL, cold spots), and high-low (HL) and low-high (LH) values. Furthermore, it allows to test the null hypothesis of absence of local spatial association, in order words whether the distribution of values around a specific

location deviates from spatial randomness (Anselin, 1995). Figure one, two and three show the univariate LISA cluster map based on 999 permutations of those five selected industries.

[Figure 1, 2 and 3 about here]

The figures show numerous hot-spots clusters in the North of Italy in almost all selected industries with some exemptions, for instance, high-high patterns are detected in Rimini and Pesaro-Urbino provinces in the central of Italy for the manufacture of metal forming machinery and machine tools industry. By contrast, the South of Italy and Islands is characterized by significant cold-spots in almost all industries with an exception of Sicily for the manufacture of other general-purpose machinery, where a significant high value of employment localization was identified in Caltanissetta surrounded by low values of LQ. Specifically, the manufacture of other general-purpose machinery (Figure one, left) shows twenty-one significant hot-spots in the North of Italy in the following provinces: Milan, Brescia, Cremona, Mantua, Bolzano, Trento, Verona, Vicenza, Belluno, Treviso, Padua, Rovigo, Udine, Piacenza, Parma, Regio dell'Emilia, Modena, Ferrara, Ravenna, Poredenone, and Lodi. In addition within this industry, LISA identifies three low-high patterns in Venice, Trieste, and Massa-Carrara, and two high-low associations in Caltanissetta and Rieti. Whereas, the manufacture of other special-purpose machinery (Figure one, right) showed twelve significant HH clusters in Cremona, Belluno, Treviso, Rovigo, Piacenza, Reggio dell'Emila, Modena, Bologna, Ferrara, Ravenna, Massa-Carrara, and Pordenone. Whereas, LH associations were detected in Vercelli, Milan, Mantua, and Venice as they showed low concentration surrounded by high localization of employment. Instead, the manufacture of metal forming machinery and machine tools (Figure two, left) showed two significant HH patterns in Rimini, and Pesaro-Urbino; and three LH associations in Forli-Cesena, Ancona, and Arezzo. Whereas, the manufacture of agricultural and forestry machinery (Figure two,

right) presents five HH associations in the provinces of Mantua, Reggio dell'Emilia, Modena, Bologna, and Ferrara; and two LH patterns in Parma and Lucca. Finally, the manufacture of general-purpose machinery (Figure three) exhibits six significant HH clusters in Vercelli, Novara, Varese, Milan, Pavia, and Verbano-Cusio-Ossola; and three LH values in Alessandria, Valle d'Aosta, and Biella.

Therefore, it emerges that the five selected industries within the two-digit manufacture of machinery and equipment n.e.c. showed high discrete localization of employment and spatial dependency in 2007 by Italian provinces, with particular reference to the North of Italy. By contrast, significant LL value associations were predominant in the South of the country and Islands. Furthermore, it is notable that some provinces showed high localization of employment surrounded by high employment concentration (HH) in more than one industry. For instance, Reggio nell'Emilia, Modena, and Ferrara provinces have significant high-high values association of three out of five industries such as the manufacture of other general-purpose machinery, the manufacture of other special-purpose machinery, and the manufacture of agricultural and forestry machinery. In addition, Piacenza, Brescia, Treviso, Belluno, Pordenone provinces showed significant high-high value associations within the manufacture of other general-purpose machinery, and the manufacture of other special-purpose machinery.

According to the classification proposed by OECD, the two-digit manufacture of machinery and equipment n.e.c. can be classified as a medium-high technology intensity industry. Therefore for this industry, the availability of skilled workers and technological spillovers play an important role in the firms' localization decision, and consequently they choose a location where these factors can be exploited. In this context, the North of Italy represents the most favourable area with the highest concentration of high and medium-high technology

intensity industries and trained workers in comparison to the rest of the country. This can explain the preponderant concentration of manufacture of machinery and equipment n.e.c. in the North of Italy. The dense localization in proximity within the same or related industries play a paramount role in the enterprise's production process and innovation capability. This inevitably fosters the development of single industry and regional industrial growth as argued by numerous authors (see, for instance, Glaeser, Kallal, Scheinkman, & Shleifer, 1992).

6 Conclusion, Limitations and Direction for Further Research

This paper was devoted to unfolding the employment concentration and autocorrelation of 95 three-digit manufacturing industries by Italian provinces in 2007 employing a composite measure based on discrete and continuous-space, since they provide complementary information in order to capture more appropriately the phenomenon of economic clustering (see, for instance, Guillain & Le Gallo, 2007). Therefore, the locational Gini was computed to investigate the discrete concentration of employment. Whereas the global Moran's *I*, Moran scatterplots, and local indicator of spatial association (LISA) were employed to detecting the global and local autocorrelation, and the significant pattern associations. Evidence showed that the industry of the manufacture of military fighting vehicles had the highest employment concentration, followed by the manufacture of motor vehicles, the manufacture of magnetic and optical media, the manufacture of man-made fibres, the manufacture of weapons and ammunition, the manufacture of air and spacecraft and related machinery, and the manufacture of batteries and accumulators. Moreover, it emerged that the manufacture of other general-purpose machinery had the highest Moran's *I*, followed by the manufacture of other special-purpose machinery, the sawmilling and planing of wood, the manufacture of metal forming machinery and the machine tools, and manufacture of cutlery, tools and general hardware. It is notable that the majority of industries with high Gini were characterized by low global autocorrelation (values close to zero in the range between

±0.05). This can be explained by the fact that they were highly concentrated within non-proximity Italian provinces. By contrast, the five three-digit industries within the two-digit manufacture of machinery and equipment n.e.c. showed a relatively high global Moran's *I* and Gini concentration as the employment was relatively concentrated and similar values were detected around contiguity observations. Therefore, these five industries were further investigated employing the local indicator of spatial associations. This allowed the identification of numerous hot-spots clusters in the North of Italy, whereas the South of Italy and Islands were characterized by significant cold-spots in almost all selected three-digit industries. In addition, it emerged that the manufacture of other general-purpose machinery had the highest number of HH values with twenty-one significant hot-spots localized in the North of Italy. Moreover, evidence showed that several provinces had HH values associations in more than one of the five selected industries such as Reggio nell'Emilia, Modena, and Ferrara, Piacenza, Brescia, Treviso, Belluno, Pordenone. This dense concentration of medium-high technology intensity industries in the North of Italy can be explained by the fact that it represents the most favourable area to establish their activities in comparison to the rest of the country, as they can exploit the availability of skilled workers and technological spillovers given by agents' proximity within the same and related industries. The economic localization in proximity generates externalities fostering firms' production and innovation, the development of single industry and an overall locational industrial growth. However, this study identified the patterns of employment spatially distributed across Italian provinces in 2007 although it does not give any information with respect to the causes of such configuration. Therefore, this is a limitation of the study and it represents the direction for further research.

7 References

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FIGURES AND TABLES

Table 1. The twenty most concentrated three-digit manufacturing industries, their relative global Moran's *I* and the five highest locational quotient of employment in Italy in 2007.

NACE 2007 & Industry Denomination	Gini	Moran's *I*	Moran's *I* Ranking	Highest Provincial LQ
304: manufacture of military fighting vehicles	0.499	-0.01	80	La Spezia, Turin
291: manufacture of motor vehicles	0.490	0.01	73	Potenza, Turin, Chieti, Avellino, Ferrara
268: manufacture of magnetic and optical media	0.488	0.13	36	Avellino, Campobasso, Naples, Cosenza, Caserta
206: manufacture of man-made fibres	0.483	0.01	74	Terni, Bergamo, Trento, Cremona, Novara
254: manufacture of weapons and ammunition	0.479	-0.01	81	Livorno, Brescia, Lecco, Pesaro e Urbino, La Spezia
303: manufacture of air and spacecraft and related machinery	0.477	0.01	75	Varese, Naples, Brindisi, Turin, Genova
272: manufacture of batteries and accumulators	0.476	0.02	71	Piacenza, Vicenza, Foggia, Bergamo, Avellino
202: manufacture of pesticides and other agrochemical products	0.467	0.19	28	Ferrara, Ravenna, Milan, Cremona, Bologna
264: manufacture of consumer electronics	0.466	0.12	40	Ancona, Reggio nell'Emilia, Macerata, Teramo, Pordenone
211: manufacture of basic pharmaceutical products	0.465	0.11	43	Vercelli, Milan, Latina, Pavia, Caserta
302: manufacture of railway locomotives and rolling stock	0.463	0.01	76	Medio Campidano, Cuneo, Savona, Caserta, Naples
241: manufacture of basic iron and steel and of ferro-alloys	0.461	-0.03	91	Genova, Terni, Valle d'Aosta, Brescia, Udine
212: manufacture of pharmaceutical preparations	0.459	0.07	56	Latina, Siena, Florence, Pisa, Sondrio
235: manufacture of cement, lime and plaster	0.453	-0.06	95	Alessandria, Bergamo, Perugia, Piacenza, Catanzaro
321: manufacture of jewellery, bijouterie and related articles	0.452	-0.01	82	Arezzo, Alessandria, Vicenza, Macerata, Florence
266: manufacture of irradiation, electromedical and electrotherapeutic equipment	0.452	-0.04	92	Vercelli, Modena, Carbonia-Iglesias, Florence, L'Aquila
275: manufacture of domestic appliances	0.451	0.04	67	Ancona, Pordenone, Varese, Alessandria, Treviso
253: manufacture of steam generators, except central heating hot water boilers	0.450	0.07	57	Bari, Varese, Perugia, Ferrara, Agrigento
309: manufacture of transport equipment n.e.c.	0.447	-0.02	90	Pisa, Chieti, Lecco, Bologna, Vicenza
322: manufacture of musical instruments	0.446	0.24	13	Ancona, Ascoli Piceno, Macerata, Rimini, Cuneo

Source: Author's computation based on 2007 data from ISTAT of Italy.

Table 2. The twenty highest global Moran's *I* of three-digit manufacturing industries, their relative locational Gini, and the five highest locational quotient of employment in Italy in 2007.

NACE 2007 & Industry Denomination	Gini	Gini Ranking	Moran's *I*	Highest Provincial LQ
282: manufacture of other general-purpose machinery	0.36	63	0.48	Belluno, Bologna, Parma, Mantua, Reggio nell'Emilia
289: manufacture of other special-purpose machinery	0.35	67	0.37	Ferrara, Udine, Pordenone, Parma, Lucca
161: sawmilling and planing of wood	0.31	85	0.34	Udine, Pordenone, Treviso, Perugia, Sondrio
284: manufacture of metal forming machinery and machine tools	0.40	41	0.32	Rimini, Pesaro e Urbino, Piacenza, Vicenza, Modena
257: manufacture of cutlery, tools and general hardware	0.39	45	0.31	Lecco, Brescia, Como, Ravenna, Cremona
204: manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations	0.42	29	0.29	Lodi, Cremona, Lecco, Rome, Mantua
310: manufacture of furniture	0.37	58	0.28	Pesaro e Urbino, Pordenone, Treviso, Matera, Udine
107: manufacture of bakery and farinaceous products	0.23	92	0.27	Parma, Nuoro, Ogliastra, Oristano, Medio Campidano
283: manufacture of agricultural and forestry machinery	0.41	40	0.26	Reggio nell'Emilia, Modena, Mantua, Isernia, Cremona
141: manufacture of wearing apparel, except fur apparel	0.33	77	0.26	Isernia, Prato, Rovigo, Teramo, Pescara
281: manufacture of general-purpose machinery	0.41	36	0.25	Novara, Vercelli, Reggio nell'Emilia, Brescia, Trieste
201: manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms	0.39	51	0.25	Ferrara, Grosseto, Novara, Verbano-Cusio-Ossola, Varese
322: manufacture of musical instruments	0.45	20	0.24	Ancona, Ascoli Piceno, Macerata, Rimini, Cuneo
267: manufacture of optical instruments and photographic equipment	0.44	21	0.24	Belluno, Vicenza, Bolzano, Pordenone, Rovigo
255: forging, pressing, stamping and roll-forming of metal, powder metallurgy	0.38	55	0.24	Lecco, Vercelli, Turin, Asti, Valle d'Aosta
293: manufacture of parts and accessories for motor vehicles	0.41	39	0.23	Turin, Asti, Chieti, Cuneo, Lodi
152: manufacture of footwear	0.38	53	0.23	Ascoli Piceno, Macerata, Pisa, Pistoia, Lecce
259: manufacture of other fabricated metal products	0.34	75	0.23	Lecco, Verbano-Cusio-Ossola, Asti, Brescia, Vicenza
139: manufacture of other textiles	0.36	64	0.22	Prato, Pistoia, Como, Varese, Biella
103: processing and preserving of fruit and vegetables	0.35	70	0.22	Salerno, Medio Campidano, Foggia, Ravenna, Parma

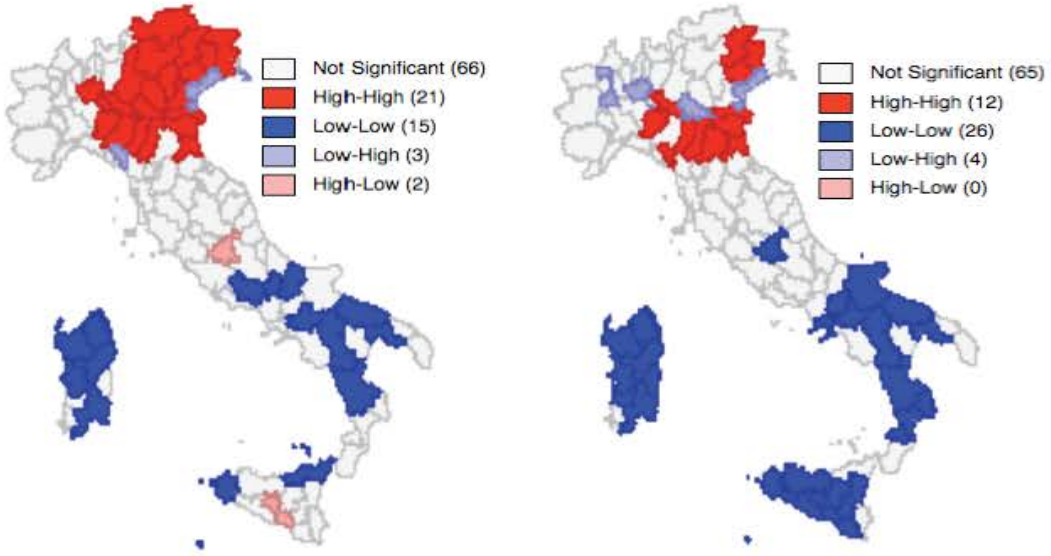
Source: Author's computation based on 2007 data from ISTAT of Italy.

Table 3. The locational Gini and the Moran's *I* of all three-digit industries within the manufacture of machinery and equipment n.e.c. in Italy in 2007 and their relative four-digit industries based on NACE 2007 classification.

NACE 2007 & industry denomination	Gini	Moran's *I*	Four-digits included in the three-digit industries
282: manufacture of other general-purpose machinery	0.36	0.48	2821: manufacture of ovens, furnaces and furnace burners; 2822: manufacture of lifting and handling equipment; 2823: manufacture of office machinery and equipment (except computers and peripheral equipment); 2824: manufacture of power-driven hand tools; 2825: manufacture of non-domestic cooling and ventilation equipment; 2829: manufacture of other general-purpose machinery n.e.c
289: manufacture of other special-purpose machinery	0.35	0.37	2891: manufacture of machinery for metallurgy; 2892: manufacture of machinery for mining, quarrying and construction; 2893: manufacture of machinery for food, beverage and tobacco processing; 2894: manufacture of machinery for textile, apparel and leather production; 2895: manufacture of machinery for paper and paperboard production; 2896: manufacture of plastics and rubber machinery; 2899: manufacture of other special-purpose machinery n.e.c.
284: manufacture of metal forming machinery and machine tools	0.40	0.32	2841: manufacture of metal forming machinery; 2841: manufacture of other machine tools
283: manufacture of agricultural and forestry machinery	0.41	0.26	2830: manufacture of agricultural and forestry machinery
281: manufacture of general-purpose machinery	0.41	0.25	2811: Manufacture of engines and turbines, except aircraft, vehicle and cycle engines, 2812: manufacture of fluid power equipment; 2813: manufacture of others pump and compressors; 2814:manufacure of other taps and valves; 2815: manufacture of bearing, gears, gearing and driving elements

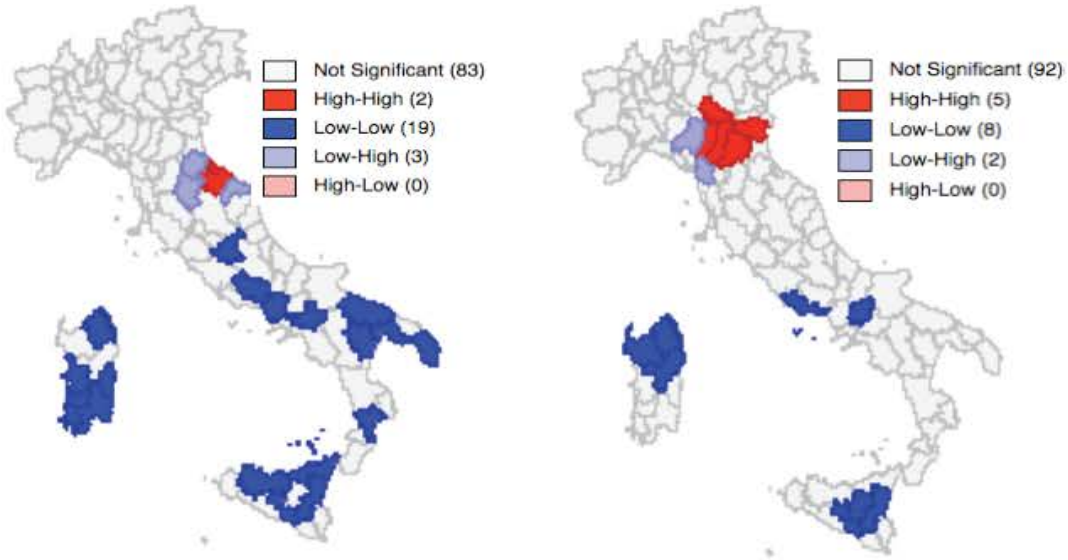
Source: ISTAT of Italy.

Figure 1. The univariate LISA cluster map (999 permutations) based on LQ employment of the manufacture of other general-purpose machinery (left) and the manufacture of other special-purpose machinery (right) by Italian provinces in 2007.



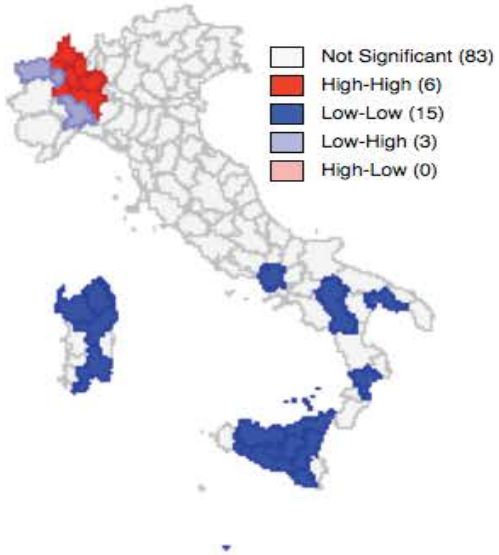
Clusters with significant p-value at 0.05.
Source: Author's computation based on 2007 data from ISTAT of Italy.

Figure 2. The univariate LISA cluster map (999 permutations) based on LQ employment of the manufacture of metal forming machinery and machine tools (left) and the manufacture of agricultural and forestry machinery (right) by Italian provinces in 2007.



Clusters with significant p-value at 0.05.
Source: Author's computation based on 2007 data from ISTAT of Italy.

Figure 3. The univariate LISA cluster map (999 permutations) based on LQ employment of the manufacture of general-purpose machinery by Italian provinces in 2007.



Clusters with significant p-value at 0.05.
Source: Author's computation based on 2007 data from ISTAT of Italy.