Measurement of Agglomeration and Spatial Effects

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Abstract

In this paper we examine the influence of spatial dependence on the estimation of the effect of standard measures of agglomeration on local growth. The hypothesis is that the forces of agglomeration do not use up their effects inside of a single local area but they extend to more wide geographic areas, and their effect fall down on the adjacent territories. To account for these spatial effects, we propose a modification of the traditional agglomeration index suggested by Maurel and Sédillot (1999), that includes both agglomeration of economic activity within an area and neighbour effects, that is, the effect of agglomeration that comes from neighbouring areas. In the empirical exercise we compute the a-spatial and the spatial indices for the set of Sicilian local labour systems (LLSs) using 21 manufacturing and services industries from the two-digit NACE-CLIO disaggregation. The results of the exploratory spatial analysis confirm that the agglomeration index varies notably when spatial effects across areas are included in the measure: both the level of the index and its degree of spatial dependence increase when it is computed accounting for spillovers across local areas. In addition, results from the estimation of a model of the local employment dynamics reveal that a big deal of the residual spatial dependence observed in this type of specification can be accounted for by the spatial measure of agglomeration. This suggests the existence of spatial spillovers that are not bounded to the local labour systems. Moreover, we distinguish the different contribution of the traditional and spatial measure of agglomeration on the growth process of the employment.

Keywords: Spatial Agglomeration, Employment Growth, ESDA, local market area.

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Introduction

This paper considers some aspects of the measures useful to estimate the agglomeration processes, occurring at a local level, focusing on the characteristics that identify the geographic units with main reference to the respective productive specialization.
Specifically, we aim to provide a methodological contribution to agglomeration literature evaluating the influence of spatial agglomeration on the employment growth in the Sicilian Local Labour Systems (LLS). LLS represent the result of the spatial aggregation of neighbouring municipalities based on the daily commuting flows of local population owing to work reasons.
On the base of the hypothesis that the forces of agglomeration do not use up their effects inside of the single SLL but they extend to wider geographic areas, we have modified the traditional agglomeration index built by Maurel and Sédillot in 1999 inverting the role of the industry with that one of the area, following the suggestion of Maré e Timmins (2006).
So we obtained a measure of agglomeration for each area and then included a spatial lag operator into the same indicator, to consider the neighbourhood effects on the adjacent territorial partitions. We built these new indices for all Sicilian LLSs and for twenty-one manufacturing and services sectors, at two digit level of NACE classification.
We notice that the agglomeration index alters notably when spatial effects across areas are included in the measure. In particular, from the Exploratory Spatial Data Analysis we can verify that spatial dependence increases stand out decidedly rather using the new measures than the traditional ones.
According to the well known growth theories [1] we consider many factors which potentially affect local employment dynamics (like competition, industry structure, diversity, scale economies, population density) focusing nevertheless on the role played by agglomeration interactions between contiguous areas on labour growth in the two inter census gaps (1981-1991 and 1991-2001). So, by means a regression model we want to examine the influence of spatial agglomeration on the employment growth process in the LLSs, together with the other variables above mentioned.
Precisely, in the first version of the model we use the traditional measures of agglomeration while in the second one employ the new measures, with the aim to distinguish the different contribution of the two types of indicators on the territorial development.
The article is organized into 5 parts: the next section will give an overview of the literature on the subject; section 2 presents our version of the agglomeration index; section 3 will feature a brief explanation of the ESDA that will be applied to the Sicilian LLS data; in section 4 we outline the impact of agglomeration effects on the employment dynamics providing a comment on the results obtained from the analysis; finally, concluding remarks are presented in section 5.

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[1] For a survey on the endogenous growth theories, exceeding the limits of our subject, refer to: Ardeni (1995), Boggio and Seravalli (2003), Capello (2004), Musu (2007).

1. An overview on the related literature

The agglomeration describes the tendency of the economic activities to concentrate in the space.
An agglomeration index assesses the propensity of the enterprises of an industry to localize in the same area considering at the same time both the random effects and those ones attributable to the dimensional structure and, at last, the effects of the geographic concentration in all industry. Therefore, the agglomeration is a more complete measure of the geographic concentration (Ellison and Glaeser, 1997). Moreover, this kind of index holds account of plant dimension, so an agglomeration index not only makes possible to evaluate the intensity of the agglomeration in a single sector, but it also allows a more correct comparative analysis over time and space among different sectors.
Industrial agglomeration phenomena have also received a particular attention by many authors interested in the assessment of positive market externalities through the recourse to the models of the so-called “new economic geography” (for a survey, see Fujita et al., 1999).
Recently, the attempt to analyze the causes of the disparities in the local economic development has stimulated a number of studies on the influence of physical proximity generating positive externalities among the subjects involved (Rice et al., 2006; Bertinelli and Decrop, 2005; Le Blanc, 2004). So, from different perspectives and by unlike analytical tools, scholars from various backgrounds (economists, geographers, historians) have contributed to outline the causes of regional specialization processes focusing on several aspects like “regional endowments or raw materials intensity, comparative advantage localization externalities, or, more recently, transport costs and market potential” (Lafourcade and Mion, 2006).
A remarkable difficulty in the study of production localization lies both in the definition of the process and in the evaluation of its effects on the distribution of economic activities.

A) Traditional measures of geographic concentration

Many authors have tried to quantify agglomeration and dispersion phenomena using more adequate statistical tools like the Gini locational coefficient. Since the original work by Krugman (1991), this measure is used in several empirical researches (Audretsch and Feldman, 1996; Amiti, 1997; Haaland et al., 1999; Midelfart Knarvik et al., 2000; Brülhart, 2001; Kim et al., 2000). Notably, Amiti (1997) employed the Gini coefficient to assess the production specialization tendencies in European countries.
The relevance given to the externalities, as the main source of agglomeration processes, is on the base of further analyses (Ellison e Glaeser, 1997, 1999; Maurel e Sédillot, 1999; Duranton and Overman, 2002; Dumais et al., 2002; Devereux et al., 2004; Combes e Overman, 2004) enlivening the scientific debate, especially in the last decade. In particular, the “dartboard” index by Ellison and Glaeser, has been introduced in a proper structural model taking into account all the foremost factors controlling for agglomeration. In a specific way, this measure provides a general definition of the agglomeration and dispersion phenomena starting from a model of location choices. It is important to note that Maurel and Sédillot (1999), in the spirit of Ellison and Glaeser, proposed a concentration index to measure agglomeration in French industries. In this strand it is possible to include the

indexes suggested by Devereux, Griffith and Simpson (1999) and Rysman and Greenstein (2004).

B) *Spatial measures of geographic concentration*

The perusing of the characteristics and intensities of interaction among the areas has determined the belief that the use of the afore-mentioned measures can produce "serious biases when quantifying a concept like industrial agglomeration" (Arbia, 2001). Following these considerations new hypotheses have been formulated as to the nature of agglomeration processes with a specific reference to the concepts of continuous or discrete space and a new measurement system has been constructed for taking into account the position of production plants in the territory.

The analytical methods based on spatial arrangement are useful to explain the structures of economic activities at different geographic scales. To this regard, we can quote the fundamental work by Ripley (1977) who proposed a method based on the K-distance function. The use of this function spread in several fields of research as showed in the works by Busch and Reinhardt (1999). In the spatial statistic literature, it is worthy mentioning the works by Marcon e Puech (2003) that propose an enhancement in the preceding methods based on the distance adopting the "M" function with the aim to analyze geographic concentration and co-location processes of many industries. Notably, the analyses by Busch and Reinhardt (1999) and Duranton and Overman (2005) insert in this particular strand.

Studies on agglomeration, indeed, fail to be persuasive when they ignore serious measurement problems or when they limit the analysis to an area without looking more closely at the externalities coming from other geographic partitions (particularly the nearest ones) constituting the economic system of the region the area belongs to. In other words, studies on the enterprises localization should "avoid placing artificial bounds to agglomeration economies" considering "the possibility of some externalities crossing borders" (Deidda, Paci e Usai, 2002) and the advantage to measure them by means of adequate indicators.

On the base of the growing importance attributed to the spatial dependence, several analyses have been carried out to estimate the effects of the cross-border externalities on local economic performance (Usai and Paci, 2001,) identifying, in the meantime, the spatial models (core-periphery pattern, contagion model etc.) characterizing various production contexts to distinguish which one is responsible of actual industrial clustering processes (Barbieri et al., 2000).

In any case, a common conclusion of the analysis carried out at a high level of territorial detail is the confirmation of the "existence of a multifaceted picture when it comes to agglomeration forces operating at local geographical level" thus "the presence of spatial association indicates that the growth process in a specific area benefits from the positive performance of the surrounding regions" (Paci and Usai, 2006).

It should be noted that many authors[2] have provided to refine the agglomeration indices proposing a list of the appropriate requirements that spatial measures have to meet. In brief, the following properties should be ensured:

[2] For a complete survey of the requirements refer to Duranton and Overman (2002), Combes and Overman (2004) and Marcon and Puech (2003).

1) Comparability of the measures across activities and across spatial scales
2) Consideration both of the agglomeration tendency in the whole manufacturing and of the market concentration level in each sector
3) Uniqueness of the value under the null hypothesis of inexistence of systematic forces acting in
the location of activities and evidence as to the significance of the measures adopted
4) Unbiasedness of the measures in relation to the changes both in spatial and industrial classification

2. The "new" index

To evaluating agglomeration forces in a particular area, in a first step of the analysis we have chosen the agglomeration index provided by Maurel and Sédillot (1999).This measure is a development of the well-known Ellison e Glaeser index (1997) and is based on location decision model.

$$\hat{\gamma}_{MS\_jt} = \frac{\left(\sum_i s_i^2 - \sum_i x_i^2\right) / \left(1 - \sum_i x_i^2\right) - H}{1 - H} \qquad (1)$$

The index ranges between -1 and 1[3].
Now, we regard the special version of M&S index arranged by Maré and Timmins (2006). They propose a measure for "local market area" and time, similar to previous one but the industry's role is replaced by the area's one. Specifically, the new formulation of M&S index is:

$$\gamma_{LLS\_MS_{it}} = \left(\frac{\sum_j s_{jt}^2 - \sum_j x_j^2}{1 - \sum_j x_j^2} - H_i \right) * \frac{1}{1 - H_i} \qquad (2)$$

However, this index makes a point of the forces operating only inside the area (LLS in our case) like the majority of standard agglomeration measures, irrespective of contiguity

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[3] The M&S index is an unbiased value of γ parameter showing three advantages. First, it is derived from a simple probabilistic location model. Second, it controls for differences in the size distribution of plants and thus provides a measure of the localization beyond the only concentration of the employment, hence an industry will not be regarded as localized only because its employment is concentrated in a small number of plants. The last advantage is that the indicator allows for comparisons among industries.

effects, and this is a limit of agglomeration indicators. The contiguity effect is determined by the intensity of attractive forces in the surrounding regions.
We have emphasized the spatial dependence on the agglomeration processes considering a spatial lag operator. First of all we regarded a binary spatial weight matrix with a row standardization. $w_{ij}^{s} = w_{ij} \Big/ \sum_{j} w_{ij}$; $\sum_{j} w_{ij}^{s} = 1$. We included a spatial lag operator *($W_{ij}E_i$)*, built by means of this matrix, working to produce a weighted average of the neighbouring observations[4].
Now we have a new formulation of index (2) considering spatial effects

$$\gamma^{S}{}_{it} = \left(\frac{\sum_{j} s_j^{spat^2} - \sum_{j} x_j^2}{1 - \sum_{j} x_j^2} - H_i \right) * \frac{1}{1 - H_i} \qquad (3)$$

The new index (3) is different from previous one (2) for s^{spat} term (4)

$$s^{spat}{}_{i} = \sum_{i} \frac{E_{ij} + \rho W E_{ij}}{E_{.j} + \rho W E_{.j}} \qquad (4)$$

$$L[X(s_i)] = \frac{1}{\eta_i} \sum_{j=1}^{n} w_{ij} X(s_j) = \sum_{j=1}^{n} w_{ij}^{*} X(s_j) \qquad (5)$$

Where ρ is a spatial autoregressive coefficient and W is a spatial contiguity weight matrix.
In this particular version $\gamma^{S}{}_{it}$ affords not only a geographic concentration measure for each area, rather than for every industry, but also consider both attractive forces within the area and between the areas, this characteristics representing the more innovative part of the measure. The new index is in continuity with the afore-mentioned measures but it overcomes their informative limits and we can have now a more complete and more exhaustive description of the localization forces.

3. Application of ESDA

In a preliminary step of the analysis we applied a method combining concentration measures and spatial dependence to the employment data taken from the Manufacturing and Service Censuses of the years 1981, 1991 and 2001 at two digit level and refer to the 77 LLSs.
Local Labour Systems (LLS) are locations in which places of work and residence come together, made up of two or more municipalities and have no relations with administrative zones. So, they represent self-contained economic-territorial spaces which provide a basis to sub-provincial analysis (Sforzi, 1989; Basile and Mantuano, 2007).

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[4] So it is possible to calculate the correlation between the employment in an area and the same variable in a contiguous area ρ= corr(E, w_{ij}E), in term of matrix we have I+ρW*E=E*I+ρW$E_{i'}$.

Exploratory Spatial Data Analysis (ESDA) allows summarizing properties of data, detecting their spatial patterns and identifying cases or subsets of cases that are unusual given their location on the map (Haining 2003). ESDA has some key characteristics:

- Methods are descriptive rather than confirmatory.
- Aims are to formulate hypotheses and to assess spatial models.
- Techniques are visual and resistant to unusual data values.
- Techniques employ few data transformations.

There are two classes of ESDA statistics: global statistics, which treat all the cases for one, or more, attributes and local statistics, which treat subsets of data one at time and may involve a sweep through the data looking for evidence of smooth and rough elements of the mapped data (Haining 2003).

ESDA techniques are only applicable to spatial data, although some are spatial equivalents of methods developed for non-spatial data, for example time series data.

We employed spatial autocorrelation that is the propensity for attribute values in neighbouring areas to be similar. In these paper the tools of exploratory spatial data analysis are used to identify the location and the delimitation of agglomeration. Particularly we employed the Moran scatterplots and Lisa statistics. Such a methodology has been applied, among others, by Guillan and Le Gallo (2006) and Lafourcade and Mion (2007).

We use the Moran index to measure spatial autocorrelation: considering quantitative variables it compares the every area values with the corresponding data of other ones. The index is represented by the following expression

$$I_{(\gamma_{MS})} = \frac{(N/S_0)\sum_{ij=1}^{N} w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{\sum_{i=1}^{N}(x_i - \bar{x})^2} \qquad (6)$$

Let N = number of Sicilian LLSs as the sample dimension;

$x_i = \gamma_{MS}$ is the variable describing agglomeration phenomenon in the i-area,

$\bar{x}$ = sample mean,

w_{ij} = weight of W matrix;

$S_0 = \sum_{i=1}^{n} w_{ij}$ is the sum of all elements not zero of matrix.

As everybody knows, this indicator expresses the correlation between a variable with itself in the space, it ranges from -1 to 1 measuring the extent to which high values are generally located near to other high values and low values are generally located near to other low values. Where the data are distributed such that high and low values are generally located near each other, the data are said to exhibit negative spatial autocorrelation.

Referring to Moran index "I", it is possible put side by side the Moran scatterplot, it accounts in Cartesian coordinates a plot of normalized variable x in the x-axis against Wx, the normalized x spatial lag, in the y-axis. The Moran scatterplot can be used to depict spatial outliers, defined as zones having values of an attribute very different from their neighbours'ones. The Moran's I is the slope of scatterplot line.

Apart from global Moran we used the local form of Moran's index, obtained multiplying the zone value times the average in the surrounding zones.

Local Indicator of Spatial Association satisfies two criteria: first, the LISA for each observation gives an indication of significant spatial clustering of similar values around that observation; second, the sum of the LISA for all observations is proportional to a global indicator of spatial association (Guillain and Le Gallo, 2006).
The local version of Moran's *I* statistic for each observation *i* is:

$$I_i = \frac{z_i}{\sum_{i=1}^{N} \frac{z_j^2}{N}} \sum_{j \in J_i} w_{ij} z_j \qquad (7)$$

where z_i is the value of normalized variable in the i-area and J_i is the set of regions neighbour to i-area.
The null hypothesis is the absence of spatial autocorrelation, so a positive value for I_i indicates spatial clustering of similar values (high or low) whereas a negative value indicates spatial clustering of dissimilar values between an area and its neighbours.
We want connect agglomeration indices with these autocorrelation measures.
Like global Moran, a positive spatial autocorrelation will occur when neighbouring regions will exhibit similar values in their agglomeration. On the contrary, this index will take on negative values when neighbouring regions will be dissimilar: namely, highly agglomerated LLSs alternate with not agglomerated LLSs in space.
In summary, Moran index results with contiguity matrix, 1^{th} 2^{nd} and 3^{rd} order, applied on traditional and spatial agglomeration measures MS are displayed in the first panel of table 1.

Tab.1 Moran index related to traditional and spatial Agglomeration measures γ_{MS} and γ^{S}_{MS} (contiguity matrix)

		I_1981	*I_1991*	*I_2001*
γ_{MS}	**1^{th} order Contiguity (Queen)**	0.0031*	0.0548*	0.0513*
	2^{nd} order Contiguity (Queen)	0.0499*	0.0198*	-0.0036*
	3^{rd} order Contiguity (Queen)	0.019*	0.0312*	-0.0171*
γ^{S}_{MS}	**1° order Contiguity (Queen)**	0.0895*	0.2559*	0.2777*
	2° order Contiguity (Queen)	0.0954*	0.2331*	0.1883*
	3° order Contiguity (Queen)	0.0237*	0.0823*	0.0669*

Where * p<.05; ** p<.01; *** p<.001

In the cases Moran applied on γ_{MS} we can see a very low autocorrelation, but this is not the case for the I_moran applied on the γ^{S}_{MS} in 1991 and 2001in which we have significance of positive autocorrelation.
However, we want to point out that there is higher autocorrelation when the index is referred to the spatial lagged agglomeration measures. Then we recalculated the Moran

index considering a different concept of neighbourhood, based on the distance not on the contiguity.
Particularly, we considered the principle K-Nearest neighbours. Specifically, two sites S_i and S_j are said to be neighbour if the distance between them is less than a threshold set in advance (whatever the threshold is selected): $d_{ij} \leq \min d_{ik} \ \forall k$. This criterion ensures each observation have exactly the same number of neighbours. Through Moran index calculated with reference to the two types of agglomeration measures, we obtained the values shown in table 2.

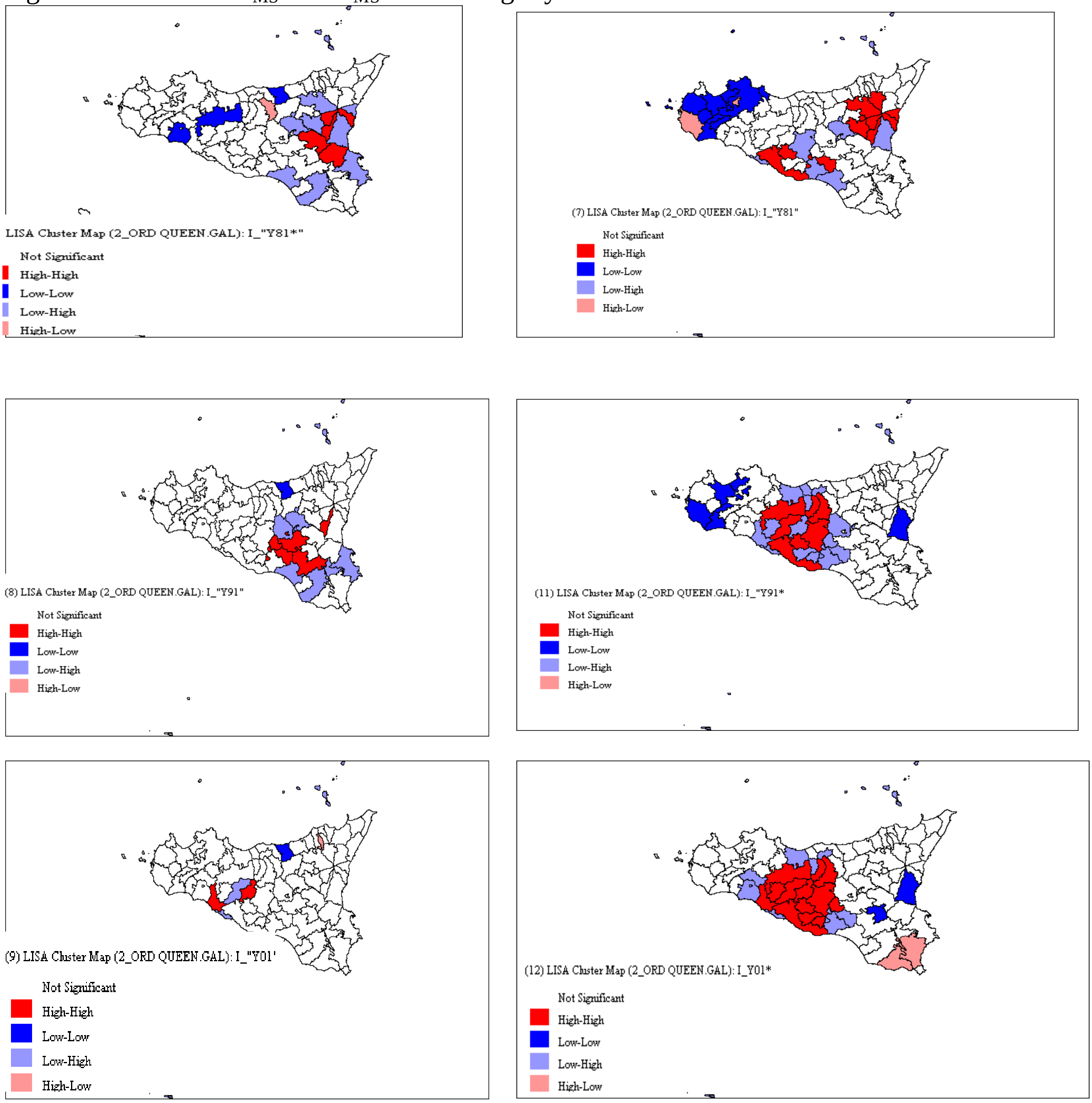
Tab.2 Moran index related to traditional and spatial Agglomeration measures γ_{MS} and γ^{S}_{MS} (distance matrix)

		I_1981	*I_1991*	*I_2001*
γ_{MS}	**Arch Distance K nearest K=4**	0.0952*	0.0565*	0.0554*
	Arch Distance K nearest K=5	0.0968*	0.0673*	0.0094*
	Arch Distance K nearest K=6	0.0352*	0.0357	-0.0099
γ^{S}_{MS}	**Arch Distance K nearest K=4**	0.1095*	0.213*	0.2175*
	Arch Distance K nearest K=5	0.1115*	0.1514*	0.1721*
	Arch Distance K nearest K=6	0.0996*	0.1918*	0.1899*

Where * p<.05; ** p<.01; *** p<.001

Moran index values are now higher than those ones obtained by means the contiguity matrix but the difference between the two typologies of index (γ_{MS} and γ^{S}_{MS}) holds over, supporting the better performance of spatial version of the indices. In confirmation of these results, from Moran index (Tab.2) the presence of positive autocorrelation is evident only for the modified indices.
Since Moran index doesn't allow assessing the statistical significance of spatial associations, Local Indicators of Spatial Associations (LISA) statistics will also be computed, considering both contiguity matrices and distance-based matrices.
For sake of brevity, here we report only LISA calculated on the second order matrix; Through them we can throw light on the location of hot spot; from the graphs (Fig. 1) we have strong proofs of positive autocorrelation. Particularly, from the local Moran index applied to the new measure is easy to single out the agglomeration cluster, in which LLSs with a high agglomeration value are surrounded by LLSs with high values. In the same way it happens for the LLSs with low values. Also the results from the application of LISA on new measures sustain our hypothesis of agglomeration forces "between" areas, not observable by the standard agglomerations measures.

Fig 1. Lisa related to I_{MS} and I^{S}_{MS} with contiguity matrix 2^{th} order order



4. The model

In this part of the paper we outline a model of the local employment growth including some factors related to the productive and structural characteristics of the selected geographical units also considering a measure of agglomeration. Specifically, in order to identifying localization benefits in a particular economic reality some aspects of business setting and, in addition, the two alternative measures of agglomeration process of the firms, have been compared with trends in the evolution of economic activities in terms of local employment.
The model will be presented in two versions: firstly, using the traditional agglomeration index built by Maurel and Sédillot, but in the formulation worked out by Maré e Timmins (agg_{jt}), eq.8; secondly, after inserting our "new" agglomeration index ($aggl^{S}_{jt}$), eq.9, to take into account the contiguity effects determined by the intensity of attractive forces in the neighbouring regions.
Owing to the lack of global autocorrelation, the least squares estimates are efficient and consistent so we use the OLS White-robust estimation which allows to correct for potential eteroschedasticity.

$$\ln(E_{i,j,t+1}/E_{i,j,t}) = \alpha_1 + \beta_2 \ln(comp_{i,j,t}) + \beta_3 \ln(div_{i,j,t}) + \beta_4 \ln(ec\_scale_{i,j,t}) + \beta_5 \ln(struct_{j,t}) + \beta_6 \ln(dens_{j,t}) + \beta_7 \ln(aggl_{j,t}) + \varepsilon_{i,j,t} \quad (8)$$

$$\ln(E_{i,j,t+1}/E_{i,j,t}) = \alpha_1 + \beta_2 \ln(comp_{i,j,t}) + \beta_3 \ln(div_{i,j,t}) + \beta_4 \ln(ec\_scale_{i,j,t}) + \beta_5 \ln(struct_{j,t}) + \beta_6 \ln(dens_{j,t}) + \beta_7 \ln(aggl^{s}_{j,t}) + \varepsilon_{i,j,t} \quad (9)$$

Having a recourse to this analytical framework, we want to examine the links among employment growth in the two inter-Census gaps (1981-1991 and 1991-2001) and the variety of the local economic environment, competition levels, scale economies, market structure and density of population, in a larger outlook considering the influence of spatial proximity, accordingly to the prevailing tendency of territorial analyses present in the current literature (Mameli et al. 2008; Patacchini, 2008; Paci and Usai, 2006; Henderson, 1995; Glaeser et al. 1992).
We remember that the basic data set always consists of 77 Sicilian Local Labour Systems with a sectoral breakdown correspondent to 21 manufacturing and services industries from the two-digit NACE-CLIO classification[5]. In order to guarantee in a measure the intrasectoral homogeneity, and a consequent better reading of the results, the analysis has been conducted separately for manufacturing and for service activities.

[5] Precisely, data pertain to the following sections of the classification NACE Rev.1.1: CA Mining and quarrying of energy producing materials; CB Mining and quarrying, except of energy producing materials; DA Manufacture of food products, beverages and tobacco; DB Manufacture of textiles and textile products; DC Manufacture of leather and leather products; DD Manufacture of wood and wood products; DE Manufacture of pulp, paper and paper products; publishing and printing; DF Manufacture of coke, refined petroleum products and nuclear fuel; DG Manufacture of chemicals, chemical products and man-made fibres; DH Manufacture of rubber and plastic products; DI Manufacture of other non-metallic mineral products; DJ Manufacture of basic metals and fabricated metal products; DK Manufacture of machinery and equipment n.e.c.; DL Manufacture of electrical and optical equipment; DM Manufacture of transport equipment; DN Manufacturing n.e.c.; G Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods; H Hotels and restaurants; I Transport, storage and communication; J Financial intermediation; K Real estate, renting and business activities

Tab. 3 Description of variables used in the analysis

	Variables	
Labour Growth	$LG_{ij} = E_{ij,t+1}/E_{ijt}$	Labour growth in two periods 1991/1981 and 2001/1991;
Competition	$Comp_{ijt} = 1/HH_{ijt}$ $HH_{ijt} = \sum_{k=}^{K} \left(\frac{E_{kit}}{E_{.jt}} \right)^2 \Big/ F_{kit}$	The Herfindahl index was built on the base of Hart's approximation (1982) producing a concentration measure from a database in which firms are divided in dimension classes depending on plant employment, in the hypothesis of equal average size of enterprises belonging to each dimensional class. H will tend to underestimate the actual concentration level, but the error is irrelevant if the number of classes is sufficiently high
Diversity	$Div_{ij} = \frac{1/\sum_{i=1, i'\neq i}^{S} \left[E_{i',j}/(E_j - E_{i,j})\right]^2}{1/\sum_{i'=1}^{S} \left[E_{i'}/(E - E_i)\right]^2}$	Inverse of a modified Herfindahl index equal to the sum of the square proportions of employment in all other sectors (i') except the one considered (i)
Economies of scale	$Ec\_sc_{ijt} = \frac{E_{ijt}/F_{ijt}}{E_{i.}/F_{i.}}$	Average plant size located in a LLS relative to Sicily as a whole. This riable represents the relative firm size in a LLS
Industry structure	$struct_{jt} = \sum_i Comp_{ijt}$	Sum across sectors of the inverse Herfindahl index based on the size distribution of the firms
Population density	$dens_{jt} = pop_{jt} / area_{jt}$	LLS population density per square kilometre
Agglomeration	$aggl_{MS\,jt} = \left(\frac{\sum_i s_i^2 - \sum_i x_i^2}{1 - \sum_i x_i^2} - H_j \right) * \frac{1}{1 - H_j}$	Standard agglomeration measure, for Local Labour System and time, including a measure concentration (H) and a measure of "Raw" concentration
Spatial agglomeration	$aggl_{jt}^{SPAT} = \left(\frac{\sum_i {s^{spat}_i}^2 - \sum_i x_i^2}{1 - \sum_i x_i^2} - H_j \right) * \frac{1}{1 - H_j}$ $s^{spat}_i = \sum_i \frac{E_{ij} + \rho WE_{ij}}{E_{.j} + \rho WE_{.j}}$	Spatial agglomeration measure in the new formulation considering contiguity effects. We have introduced a spatial lag operator in the term (sj) of index that refers to every share of territory.

Following the suggestion of Paci and Usai (2006), we aim "to control for potential causes of distortion by excluding all local industry observations with a zero number of firms either in the initial or in the final year because this gives rise to extreme values with typical outlier characteristics". It should be noted that also in our models "all regressors are exogenous to

the local industry employment growth rate since they refer to the beginning of the period considered”.
R^2 values are rather low, like “are to be expected in cross-sectional models of this kind” (Mameli et al., 2008). Multicollinearity was tested calculating the Variance Impact Factor, VIF, for each regressor. The VIF presents a minimum value of 1 (no multicollinearity) and no upper bound but “a popular cut-off value of 10 is normally used to show that multicollinearity is present” (Mameli et al. 2008).
In our models, the highest VIF values is 3.36.

Tab. 4 Results of the empirical analysis

	1991/1981			
	Manufacturing		***Services***	
	Model 1	*Model 2*(new γ)	*Model 1*	*Model 2*(new γ)
Agglom_trad	.9281		-.3496	
Agglom_spat		.9967 *		-.8723 *
Comp	-.00095	-.00086	-.00008 **	-.000082
Density	.00013	.00015	.00016	.00014
Div	.6305 *	.6506 *	-.1491	-.1552
Ec_scale	-.2033 ***	-.2021 ***	-.0431	-.0366
Structure	-8.7e-06	-8.73e-06	-.00001	-8.4e-06

Where * p<.05; ** p<.01; *** p<.001

As shown in Tab. 4 in the first inter-census gap, the traditional version of the agglomeration index doesn’t exert any impact on the change of employment, both in manufacturing and in service industries, while the new index, measuring the agglomeration forces exerting their effects also in the surrounding areas, shows to be somewhat influent, even if with opposite signs, on the two sectors employment.
Conversely, scale economies prove a substantial negative influence in the evolution of manufacturing workforce, positively conditioned, in the same break, by the variety in the economic environment. With respect to the service activities the coefficients of these last two regressors are both negative and not significant and, only for the first model, the negative impact of the competition level becomes evident.
As far as we can see, it would appear that only for the first gap (1981-1991) the Sicilian production system has been characterized by high size levels of manufacturing firms assuring consistent internal scale economies accompanied – in a measure - by cross-border externalities and a diversified economic environment. In service sector only spatial agglomeration forces have produced significant, but negative, effects on the occupation chances for the manpower expelled from other economic activities.
The findings obtained for the second gap (1991-2001) (table 5) reveal that the situation changed in the two sectors.

Tab. 5 Results of the empirical analysis

	2001/1991			
	Manufacturing		**Services**	
	1 Model	2 Model (new γ)	1 Model	2 Model (new γ)
Aggl	0.00045		-.3276	
Aggl_spat		.9138*		-.3243*
Comp	0.2044***	.01147*	-00012***	-.00012***
Density	0.2233*	.0024**	.000008	.00001
Diversity	-.1029	.7514	.0077	.00967
Ec_scale	.73319***	.9370**	-.0418	-.0406
Struct	.1531*	.0002	.00003*	.0004*

Where * p<.05; ** p<.01; *** p<.001

According to the first model, the standard agglomeration measure doesn't play any role in the explanation of manufacturing employment change; instead, a competitive environment, the presence of scale economies and the industry structure show to have a positive influence on the occupation trend.

In the second model, always for manufacturing, spatial agglomeration index shows that the agglomeration forces exert a positive impact on local growth together with competition, scale economies and industry structure.

With regard to service sector, the significance of spatial agglomeration is also confirmed in the second version of the model, but agglomeration has a negative role on employment tendency like structure and, in a substantial way, competition.

It is important to note that Sicilian employment, in the sectors examined, has presented different trends. While manufacturing has undergone a consistent decrease in the two periods (-13.25 % and -9.42%, respectively), service sector showed a growth of 11.82 % during the first gap and a light reduction (-1.04%) in the second one.

The economic interpretation of the important effects depending on the spatial agglomeration is made difficult because of the opposite signs (positive in manufacturing and negative in services) shown by this variable in the two activity groups.

As above mentioned, local labour market was characterized by contrasting employment trends in the first inter-census gap suggesting that services have received, to some extent, the workforce coming from industrial activities.

In the second period, instead, the decrease of employment in both sectors (although less marked in services) possibly was due to the different mix of the respective labour demand, and/or to the consequent saturation of tertiary employment, stopping traditional service function to absorb the exceeding manpower.

Thus, the conclusions that could be derived from the results of the analysis are to be inserted in a scenario of a generalized decline of the Sicilian production activity, specially in the last inter-Census gap, mainly remarked by the high territorial disaggregation level of the geographic units considered in this work.

5. Concluding remarks

The traditional measures of concentration are based on the hypothesis that the agglomeration forces among plants appear only inside of a single area and they don't have effect outside of it. Instead, there exist forces that have an influence not only inside of the predetermined areas borders but can also outreach in neighbouring areas.

According to this point of view, we have provided a methodological contribution to the agglomeration literature proposing a transformation of the traditional measures, with the aim of overcoming their limitations. In this work, we refer to Maré and Timmins version of the Maurel and Sédillot index where they invert the industry's role with the area's role having, in this way, a synthesis of agglomeration process for each area. We have emphasized the spatial dependence on the agglomeration processes considering a spatial lag operator to take into account both attractive forces within the area and between the areas.

The findings from ESDA have supported the better performance of the new index (γ^{S}_{it}) , built to controlling for the influence by factors which are outside each geographic unit, in comparison with the agglomeration traditional measure. From local Moran indices the presence of positive autocorrelation results only for the modified index, sustaining our hypothesis of agglomeration forces "between" areas, not observable by the standard agglomerations measures.

Subsequently, an empirical analysis was carried out pointing to the dynamics of employment, in the 77 Sicilian Local Labour Systems, to evaluate the effect of the agglomeration forces above mentioned by using our index.

In conformity with the well-known growth theories, we considered many factors which potentially affect local employment dynamics (like competition, industry structure, population density, diversity, scale economies) focusing, nevertheless, on the role played by agglomeration interactions between contiguous areas on labour growth in the two inter-census gaps, separately for the macro sectors manufacturing and services.

In other words we wanted to examine the influence of spatial agglomeration on the employment growth process in the LLSs, along with other variables commonly employed in literature.

In the first version of the model we used the traditional measures of agglomeration while in the second one we included the new measures, with the aim to distinguish the different importance of the two types of indicators on the territorial development.

Other contribution of this paper is, therefore, the analysis of local economic performance, as expressed by employment dynamics, both in the service and in the manufacturing sectors. Thanks to a large set of variables and data we attempted explaining some of the differences in the economic performance by assessing the role of several potential determinants of local economic dynamics (Paci and Usai, 2006).

Results we have obtained from the analysis confirm the existence of agglomeration forces positively influencing manufacturing but negative for service sector, operating at local geographical level for the two periods examined. Specifically, the employment trends show a clear spatial dependence from the agglomeration. This phenomenon, additionally, contributes to better understand the nature and the importance of the variables expressing the characteristics of the production systems at LLS levels. For this reason, in particular, we aim to deepen in a future research the effects of agglomeration forces on the determinants of growth to perform a wider relation frame explaining local development paths.

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