The Economics of European Regions: Theory, Empirics, and Policy

Dipartimento di Economia e Management

Co-funded by the Erasmus+ Programme of the European Union

Project funded by

European Commission Erasmus + Programme –Jean Monnet Action

Project number 553280-EPP-1-2015-1-IT-EPPJMO-MODULE

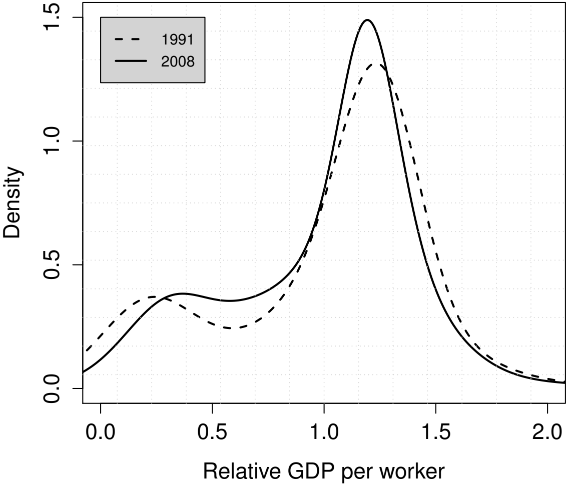
Davide Fiaschi Angela Parenti[1]

December 9, 2019

[1]davide.fiaschi@unipi.it, and angela.parenti@unipi.it.

Distribution of Regional GDP per Worker

	1991	2008
Gini	0.25	0.23
BIPOL	0.83	0.78



Geographical Distribution of Regional GDP per Worker

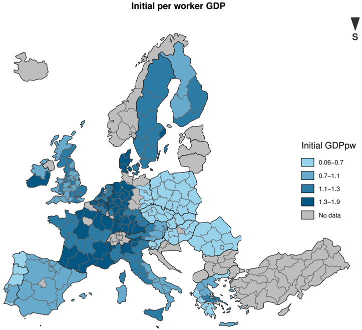


Figura: Regional GDP per Worker in 1991

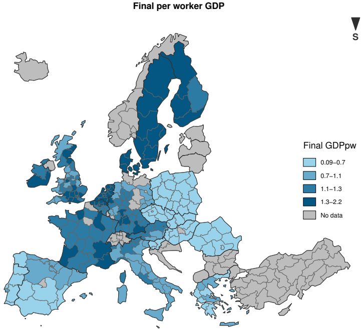


Figura: Regional GDP per Worker in 2008

Geographical Distribution of Structural and Cohesion Funds

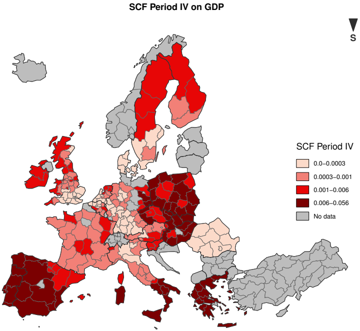


Figura: Structural and Cohesion Funds in 2000-2006

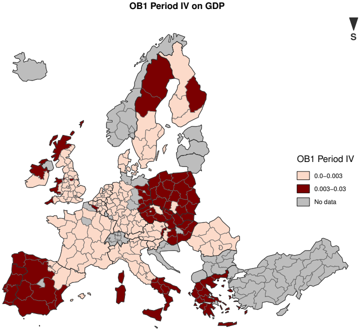


Figura: OB1 Funds in 2000-2006

The W Matrix

- The definition of the relation among economies in terms of their spatial structure is ambiguous.

The W Matrix

- The definition of the relation among economies in terms of their spatial structure is ambiguous.
- Differently from the time series analysis, where the notion of lagged variable is fairly unambiguous, in spatial analysis matters are complicated (Anselin, 1998).

The W Matrix

- The definition of the relation among economies in terms of their spatial structure is ambiguous.
- Differently from the time series analysis, where the notion of lagged variable is fairly unambiguous, in spatial analysis matters are complicated (Anselin, 1998).
- It must be assumed that observations are organized in spatial units, which may be points in a regular or irregular lattice, or regions on a map.

The W Matrix

Neighbours in space

Consider a variable X observed for each spatial units $i = 1, ..., N$. A set of **neighbours** for a spatial unit i is defined as the collection of those units j for which:

$$\{j | P(X_i) \neq P(X_i | X_j) \text{ and } d_{ij} \leq \epsilon_i\} \tag{1}$$

that is, as those locations for which the unconditional probability for X_i is different from its conditional probability given X_j.

The W Matrix

Neighbours in space

Consider a variable X observed for each spatial units $i = 1, ..., N$. A set of **neighbours** for a spatial unit i is defined as the collection of those units j for which:

$$\{j | P(X_i) \neq P(X_i | X_j) \text{ and } d_{ij} \leq \epsilon_i\} \quad (1)$$

that is, as those locations for which the unconditional probability for X_i is different from its conditional probability given X_j.
d_{ij} is a measure of the **distance** between i and j in a proper structured space and ϵ_i is a critical cut-off point for each spatial unit i, possibly the same.

Spatial Contiguity Matrix

The original measure of spatial autocorrelation is the **binary contiguity** between spatial units:

Spatial Contiguity Matrix

The original measure of spatial autocorrelation is the **binary contiguity** between spatial units:

- the underlying structure of neighbours is expressed by 0-1 values;

Spatial Contiguity Matrix

The original measure of spatial autocorrelation is the **binary contiguity** between spatial units:

- the underlying structure of neighbours is expressed by 0-1 values;
- if two spatial units have a **common border** of non-zero length they are considered to be contiguous and a value 1 is assigned;

Spatial Contiguity Matrix

The original measure of spatial autocorrelation is the **binary contiguity** between spatial units:

- the underlying structure of neighbours is expressed by 0-1 values;
- if two spatial units have a **common border** of non-zero length they are considered to be contiguous and a value 1 is assigned;
- it obviously assume the existence of a map;

Spatial Contiguity Matrix

The original measure of spatial autocorrelation is the **binary contiguity** between spatial units:

- the underlying structure of neighbours is expressed by 0-1 values;
- if two spatial units have a **common border** of non-zero length they are considered to be contiguous and a value 1 is assigned;
- it obviously assume the existence of a map;
- several order of contiguity may be considered.

General Spatial Weight Matrix

- To account for *general measure* of **potential interaction** between two spatial units;

General Spatial Weight Matrix

- To account for *general measure* of **potential interaction** between two spatial units;
- $\Rightarrow$ **Spatial Weigth Matrix** W:
  - is based on some definition of distance as geographical distance, travel time, trade patterns etc.
  - may be symmetric or not
  - may be row-standardized

General Spatial Weight Matrix

- To account for *general measure* of **potential interaction** between two spatial units;
- $\Rightarrow$ **Spatial Weigth Matrix** W:
    - is based on some definition of distance as geographical distance, travel time, trade patterns etc.
    - may be symmetric or not
    - may be row-standardized

The matrix W is required because in order to address spatial autocorrelation and to model spatial interaction, we need to impose a structure to constrain the number of neighbours to be considered.

General Spatial Weight Matrix

- To account for *general measure* of **potential interaction** between two spatial units;
- $\Rightarrow$ **Spatial Weigth Matrix** W:
  - is based on some definition of distance as geographical distance, travel time, trade patterns etc.
  - may be symmetric or not
  - may be row-standardized

The matrix W is required because in order to address spatial autocorrelation and to model spatial interaction, we need to impose a structure to constrain the number of neighbours to be considered. This is related to Tobler's first law of geography, which states that *"Everything depends on everything else, but closer things more so"* - in other words, the law implies a spatial distance decay function, such that even though all observations have an influence on all other observations, after some distance threshold that influence can be neglected.

The Moran's I

Indicators of spatial association are statistics that evaluate the existence of clusters in the spatial arrangement of a given variable.

The Moran's I

Indicators of spatial association are statistics that evaluate the existence of clusters in the spatial arrangement of a given variable.
Global spatial autocorrelation is a measure of the overall clustering of the data. One of the statistics used to evaluate global spatial autocorrelation is Moran's I, defined by:

$$I = \frac{\frac{N}{S_0} \sum_i \sum_j W_{ij} Z_i Z_j}{\sum_i Z_i^2} \tag{2}$$

where:

- Z_i is the deviation of the variable of interest with respect to the mean;
- W_{ij} is the matrix of weights that in some cases is equivalent to a binary matrix with ones in position i,j whenever observation i is a neighbour of observation j, and zero otherwise;
- $S_0 = \sum_i \sum_j W_{ij}$.

The Moran's I

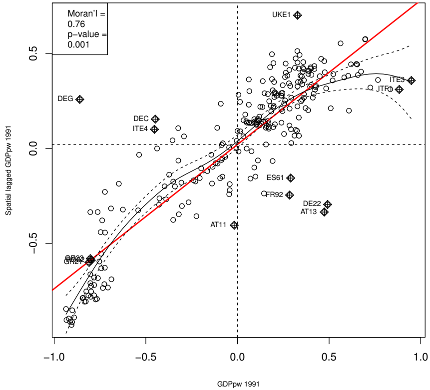
Indicators of spatial association are statistics that evaluate the existence of clusters in the spatial arrangement of a given variable.
Global spatial autocorrelation is a measure of the overall clustering of the data. One of the statistics used to evaluate global spatial autocorrelation is Moran's I, defined by:

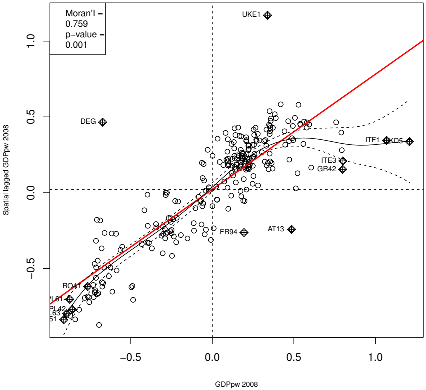
$$I = \frac{\frac{N}{S_0} \sum_i \sum_j W_{ij} Z_i Z_j}{\sum_i Z_i^2} \tag{2}$$

where:

- Z_i is the deviation of the variable of interest with respect to the mean;
- W_{ij} is the matrix of weights that in some cases is equivalent to a binary matrix with ones in position i,j whenever observation i is a neighbour of observation j, and zero otherwise;
- $S_0 = \sum_i \sum_j W_{ij}$.

Negative values indicate negative spatial autocorrelation and the inverse for positive values. Values range from -1 (indicating perfect dispersion) to +1 (perfect correlation). A zero value indicates a random spatial pattern.


Moran'I =
0.76
p−value =
0.001
UKE1
ITE3
ITF1
DEG
DEC
ITE4
ES61
FR92
DE22
AT13
AT11
GR21
Spatial lagged GDPpw 1991
GDPpw 1991


Moran'I =
0.759
p−value =
0.001
UKE1
DEG
ITF1
KD5
ITE3
GR42
FR94
AT13
RO41
PL61
PL42
Spatial lagged GDPpw 2008
GDPpw 2008

The LISA

Global spatial analysis or global spatial autocorrelation analysis yields only one statistic to summarize the whole study area. In other words, global analysis assumes homogeneity. If that assumption does not hold, then having only one statistic does not make sense as the statistic should differ over space.

The LISA

Global spatial analysis or global spatial autocorrelation analysis yields only one statistic to summarize the whole study area. In other words, global analysis assumes homogeneity. If that assumption does not hold, then having only one statistic does not make sense as the statistic should differ over space.
But if there is no global autocorrelation or no clustering, we can still find *clusters at a local level* using **local spatial autocorrelation**.

The LISA

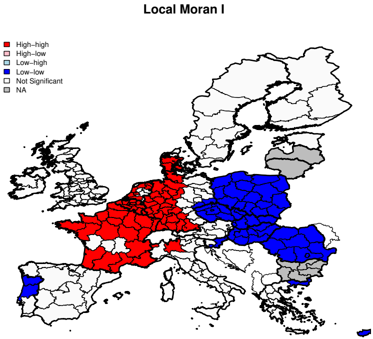
Global spatial analysis or global spatial autocorrelation analysis yields only one statistic to summarize the whole study area. In other words, global analysis assumes homogeneity. If that assumption does not hold, then having only one statistic does not make sense as the statistic should differ over space.
But if there is no global autocorrelation or no clustering, we can still find *clusters at a local level* using **local spatial autocorrelation**. The fact that Moran's I is a summation of individual crossproducts is exploited by the "Local indicators of spatial association" (**LISA**) to evaluate the clustering in those individual units by calculating Local Moran's I for each spatial unit and evaluating the statistical significance for each I_i:

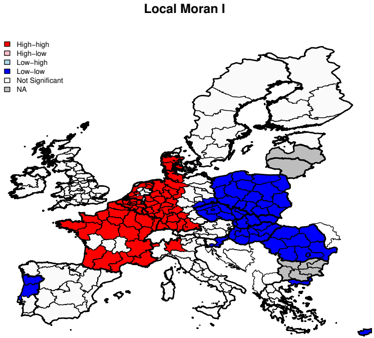
$$I_i = \frac{Z_i}{m_2} \sum_j W_{ij} Z_j \tag{3}$$

where:

- $m_2 = \frac{\sum_i Z_i^2}{N}$

I is the Moran's I measure of global autocorrelation, I_i is local, and N is the number of analysis units in the map.


Local Moran I
High−high
High−low
Low−high
Low−low
Not Significant
NA


Local Moran I
High−high
High−low
Low−high
Low−low
Not Significant
NA