Augusto Ascolani, Giuseppe Espa, Rossella Baldini

Measuring spatial concentration of the population: a new approach

When analysing the spatial distribution of the population and human activities it is noticeable that these phenomena are not evenly intensively spread, but, quite the contrary, tend to be dispersed irregularly across the space. With respect to economic activities, this tendency towards „irregularity“ and towards accumulation around certain points (or poles) which show a distinct value of attractiveness or polarisation, lead to the result that a particular aspect which is more striking for us than all others is clearly unearthed: the aspect of concentration.

In detail, economic theory and regional analysis have resulted in different hypotheses of interpretation and localisation models when dealing with the subject of the concentration of economic activities in the last few years, whereas other impulses for the above-mentioned investigations originated from the development of reconciliation processes, as for example Europe's and from problems arising from them. In this connection, remember, for example, the discussion on the possibility as to whether the economic integration would lead to an accentuation of the concentration of economic activities or not, in view of the fact that a reduction of regional disparities are a priority target of the European Union.

When regarding the subject of demography, for which space is the basic framework of a habitat whose configuration is not only expressed in economic factors, the development concerning the spatial distribution of the population is not less strong. The tendencies for urbanisation which had prevailed for a long time became weaker and weaker until they made room for contrary developments and lead to approaches for interpretation - also conflicting – which nourished in depth discussions in the field of demography and other disciplines effected.

In view of the further development of the models as well as the theoretical and interpretative assumption in the above-mentioned disciplines, the fact that literature on the empirical measurement of the spatial concentration has not further developed is surprising. In fact, the majority of the empirical studies is based on the calculation of localisation indices and disparity measurements which completely ignore the spatial nature of the data to be examined.

An example for this is the theoretical approach of Krugman in 1991[1], which is based on the statistic evidence of a sample of the geographic concentration of American manufacturing companies, which was shown using the Gini coefficient. The same index, on the other hand, is often used in demographic studies which analyse the aspect of territorial concentration of the population.

This study, in turn, is based on the perspective that the localisation index of Gini, as any other static disparity measurements, is a-spatial per se and as such not suitable to describe and summarise geographic phenomena. As the decision-makers in the economic and social policy areas rely on concentration measurements (and will do so even more in the near future), it is clear that it is of main importance, first to emphasise the importance of the measurement of the geographical dispersion and, second, to develop new instruments which are in a position to capture the true spatial nature of the data.

For this purpose it will be shown that the phenomenon of the spatial concentration is the result of the interaction of two different forces: a-spatial heterogeneity and polarisation. Those methods of measurements, however, which are usually used in empirical examinations, are only able cover the first of these characteristics.

[1] P. Krugman, *Geographic and trade*, MIT Press, Cambridge, Massachussets, USA

Indeed, each of the standard methods for measuring of variability and concentration, usually applied in empirical examinations, contains a so-called „anonymity characteristic“ as regards the individual statistical units. This means that these indices are non-sensitive towards all changes in the arrangement of the individual statistic units. In other words: The index value is completely non-sensitive towards the relative position of the areas, which form a certain local partial area, for this reason a spatial configuration can correspond to one and the same index value which, in terms of polarisation, may correspond to a clearly different situation. In this case, the problem is based on the difficulty to select the required instruments, with which the individual situations, which correspond to each possible arrangement of the individual statistical units (regions) can be characterised in a suitable manner so that the degree of polarisation which identifies them can be measured and so that they can be ordered on the basis of a quantitative scale.

A concrete possibility for the identification of different cases of polarisation, for example, is provided by the spatial correlation coefficient of Moran (and/or of Cliff and Ord), i.e. by measurements, which are based on the concept of serial correlation in strict analogy. The spatial correlation coefficient of Moran provides us, in deed, with a method of measurement, with which different polarisation situations can be covered in a suitable manner. The coefficient is able to use negative, zero or positive values and fluctuates mainly between -0,5 and +0,5. Positive values of the spatial correlation coefficient are connected to a high degree with polarisation, whereas negative results are linked to a low degree with spatial correlation, which implies the spatial dispersion of data within the area investigated. If the spatial correlation coefficient is a zero value, no special geographic regularities can be ascertained as the data is distributed within the geographic area investigated following a random principle.

However, it has to be pointed out that the spatial correlation coefficient as such is also no method for the measurement of the spatial concentration in the sense understood by this paper. Some simple examples clearly show that situations which are characterised by the same level of spatial correlation (by an identical value of the Moran index), in reality differ considerably in their Gini values. In this case, the Moran index is, in turn, insensitive towards the general variability of the phenomenon.

The conclusion which can be drawn from the previous considerations is that, if the spatial distribution is to cover the a-spatial concentration as well as the polarisation, it is required to examine both components simultaneously[2]. An examination with the target to identify a-spatial concentration and polarisation at the same time may start with the examination of a graph with the name GI-plot in the Cartesian coordinate systems which shows the value of the polarisation index of Moran (I) on the abscissa and the value of the Gini relation (G) on the axis of ordinates.

The area of the GI plot on top right refers to a situation with increased spatial concentration, i.e. here are those areas which are characterised by an increased a-spatial concentration (G>0,5) and an increased polarisation (I>0). In contrast to this, the area on the bottom left shows the situations in which the spatial concentration is low; actually, the cases examined show a low a-spatial concentration connected (G<0,5) with a negative spatial correlation (I<0).

However, it is clear that the GI-plot does not represent a complete order of different geographic situations which are encountered in practice, but only a quasi order[3] in relation to complex situations which differ from those shown in the above-described quadrants. It is also obvious that the GI-plot is a descriptive instrument for the visualisation of the value of both

[2] G. Arbia, G. Espa, *The empirical analysis of the spatial concentration*, Quaderni di Statistica, 1/1998, Dipartimento di Metodi Quantitativi e Teoria Economica, Università “G.D’Annunzio”, Pescara.Rome.
[3] A. Sen, *On economic of inequality*, Clarendon Press, Oxford, 1972.

components in an Cartesian system of coordinates which enables it to show how the importance of geographic situations for the concentration of the population.

This paper examines the described methodology at the example of the Italian population, namely related to the last two censi of population (1991 and 2000), with the target of evaluating which perspectives of polarisation from characteristic aspects correspond with the manifestation of tendencies towards a-spatial concentrations which have been determined in the last few decades and quantified with the Gini coefficient.

The development of the characteristics of distribution of the Italian population, which is dispersed in approx. 8000 communities, which form the elementary units of administration shows clearly a comprehensive process of migration from the rural areas, the inland and the mountain regions, which together with the tendency of migration into the northern areas and, in general, into the larger cities have caused a progressively territorial agglomeration of the population. This can be found at all levels of territorial accumulation: related to the whole country, individual parts, regions and provinces.

These tendencies towards concentration were in the most important industrial region clearly stronger than in others – depending on the geographic location.
After 1981, a minor, however, meaningful decline of the index starts which relates clearly to the tendencies of decentralisation which have been observed in the whole country since then. The differences in the degree of concentration between the large parts of the country are still considerable, in Central Italy, this phenomenon has reached the highest values (attractiveness of Rome). The value sin North Italy, however, do not deviate from the average values of the countries, whereas South Italy where the degree of centralisation of population grow slower than in the rest of Italy, still differs considerably, which reflects the special features of its urban structure and the slower development of its economy. In South Italy as well, the tendencies towards demographic decentralisation and the migration of the population leaving the large towns are, however, also increasing.