**Peri-urban areas zoning.**
**Testing a new method of classification for the Lombardy region.**

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*Abstract*
Today, city is exploded in its suburbs and surrounding rural areas. To distinguish it from other territories is therefore difficult. To do this, it is possible to use different zoning models. However, each of them shows some problems: some of them are urbanocentric, other generic or inaccurate and some uses complex statistical techniques or difficult to understand by non-experts. This paper paper highlights the need to test a new method of classification which does not have such problems and it could be easily replicable in different regional contexts. At the same time, it offers an original method, specifically tested for the Lombardia region (IT).

*Introduction*
Urban spread in rural landscape is evident in Europe (EEA, 2006). The need to regulate relations between rural and urban areas is not recent, but today it takes on a new importance, and in some cases, an obvious urgency.
Mapping and interpreting these changes is very complex.
Rural areas cannot be construed so as residual and passive territories. Today, there are dynamic and active counterparts, despite the endogenous weaknesses of primary sector. Similarly, urban areas and in particular their traditional attractiveness are in crisis due to spatial transformation of production. In the middle, there is a continuum that, disorderly, combines the characteristics of both territories.
It follows the partial worthlessness or inapplicability of rigid regional planning forms based on functions hierarchy, as well as the rational separation of spaces allocated to them. Early models of land use have often underestimated this problem and neither the promotion of urban transformation campaigns, or restraints of urbanization have resulted optimal (Benevolo, 2011).
To reform them, it is necessary to start from the correct territorial mapping. Understand what are rural, urban and periurban areas is not a simple exercise, but it is a starting point for experimenting with new planning models and implementing the correct policies for territorial governance.

*Contemporary city*
The contemporary city is changing its essential features in a rather drastic way and is indeterminate in many of its core elements (Treu, 2009 a, b).
It is not “the historic city”, or the “compact city” of the Nineteenth century and even the “modern town” typical of the industrial development of the early Twentieth century. It is not “the old city” that lacks a specific order or the desire for harmony, but it is a "new city” that seeks innovative elements in replication of its facilities in new local contexts.
It is infinite (Bonomi, Abbruzzese, 2004), shirinked (Schwartz et al., 2005), fringed, researcher, coalescent, blunt and sociability light (Cattivelli 2012th) and resilient (resilience.org, 2012). Its shape is porous and uncontrolled. There is not a clear distinction of its constituents and its boundaries that, in the past, were separated from the external environment and strengthened of the sense of security and of belonging to the community it established (Treu, 2006a). From it, it starts a dense branching of relationships and intangible assets that extend into a new landscape that is no longer the city and even the country, but it is a *continuum* of interconnected and exploded settlment

(Camagni, 2008), to form a polycentric metropolis with moments of concentration or dissemination of jobs (commuting) and settlements (dormitory town, orbital commuting and congestion).
Periphery loses its traditional connotation of dependent site, it is deprived by differences and identity, as well as architectural quality and original reports with the reference context. It acquires the status of a “transition area”, “tangible and fragile place”, with ability to change that, sometimes, is not expressed. It has a low population density and a variety of uses and destinations. It loses rural aspects (due to the reduction of fertile soil, land to be used for agricultural purposes, etc.) and it has not any urban attributes (low density, limited accessibility, limited availability of services and infrastructure).
Land use is high, due to urban sprawl and conflict in its distribution between economic activities and biodiversity is threatened (EAA, 2006). Of the remaining, there is a structural degradation, due to the agro-eco system fragmentation and the insularisation of its fragments in the mesh infrastructure and the built environment. To protect it, more dense ecological networks are realized. These networks helps to balance the need to protect and enhance the environmental quality (rather poor), but, at the same time they can be helpful to define the boundaries (often transient) with the surrounding rural areas. Similarly, urban gardens and other forms of peri-urban agriculture widespread.
Their implementation, especially if they are "open green spaces" or artificial ecosystems, however, is hampered by the risk of formalism (bureaucratic or planning) and production requirements.
City returns to be a development matrix as well as an ideal place for the development of economic activities in the past delocalized (Cattivelli, 2012b).
The relocation outside of the city has resulted in an increase of localization economies, but also a split between production or settlement concentration or the rest of urban areas; later, the localization economies have been reduced due to the reduction of incentives to the location in remote areas, difficulties in obtaining raw materials or human capital or access to the transport network. Therefore, a lot of firms revised their location choices. The immediate (and later positive) solution, was the return to the first urban periphery where it is possible to enjoy the positive effects of proximity to urban centers, but without having to incur the high costs involved.
Within a few years, city has had to respond to the changes introduced by flexible manufacturing models typical of network local economies and address the problems related to the contrast between production places, access to complementary resources and markets and new locations. At first, in fact, it is "emptied" of certain assets (mainly those with higher endowment of physical capital), now it should absorb them again, in a local context strongly different. It is therefore looking for its own (and particularly) economic vocation. Finally, city changes and is changed by rhythms, time shifts, schedules and choices of civil society. Part of working population leaves it in search of cheaper housing or more healthy living conditions, retirees return to their place of origin to the rediscovery of traditions and way of life healthier.

*Countryside, today*
Countryside is now a succession of empty and full spaces, marginal areas and rehabilitated areas, evident concentration of population and economic activity or disorderly dispersion of settlements, sometimes abandoned. Then it has a variety of landscapes, such as small towns and cities, forests, farms, greenfield sites, industrial concentrations and crops. It has also a social structure and relationship that no longer rests on typical values of peasant society and an economic structure based not only on agriculture.
Its reading is much more complex.
It can be interpreted as a new social system, natural environment, production environment or area by different accessibility or set of values (Cattivelli, 2012c).
Rural areas (predominantly rural and intermediate regions) account for 91% of EU27 territory. In them, 59% of European population lives and 48% of the EU GDP are produced (European Union Directorate-General for Agriculture and Rural Development, (2012). Dijkstra and Poelman’s study (2008) shows that in 1995-2004, in Europe, the so-called intermediate regions record higher annual

growth rates, predominantly urban regions follow immediately. Rural regions show values close to zero, while the remote rural areas negative values.
Net migration is high in predominant rural areas due to the demographic shift that has affected urban areas (Copus et al., 2006). Migratory movements recorded in rural areas subject to urban influence are not as consistent as the out-migration or migration from urban core to suburban areas. Rural areas, especially remote, suffer from depopulation in favor of peri-urban areas placed under urban expansion pressure. The deep-rooted and strong urbanization compares to the counter-urbanization, a phenomenon of opposite sign which sees the population growth in peri-urban fringe or in greater accessibility rural areas.
The country is also a set of geomorphology, climate, soil and environmental details. They are right Zaccherini and Merlo (1992) when they write that: << What is currently used to distinguish rural areas from urban areas are its specific ecological characteristics, remaining the countryside a particular natural environment different from urban one and perceived as such by the people >> (p.22). Ambrosio-Albala and Delgado (2008) prefer to read the peasantry in a not conflict way with urbanity, but in the context of greater sociability. Not surprisingly, defines a rural area as ‹‹a social system embedded in ecological surroundings and whose survival depends, among others, on its interrelations with the system of natural resources›› (p.4).
Both considerations seem to underlie a sort of "natural identity" that makes these areas particular Szakal precises (1999): ‹‹rural area is an extremely complicated, versatile, multifunctional system of resources››(p.312).
Today, the amount in the natural green elements is subject to a strong intensification or reduction due to the depletion in their use. Similarly, their diversity is threatened. The characteristics of identity of rural areas are approved. In particular, agricultural areas of monoculture of industrial agriculture and policultural landscapes typical of the traditional coexist in the same space. Rurality is autonomous in its determinants and in the direction of its economic development.
However, than in urban areas, there are substantial differences in prevailing activity, in requested capabilities and applications, in the value-added, in the income levels, in the organization and methods of production (OECD, 2009). The weakness of rural areas is no longer determined by the reduced productivity of economic activities, but rather from the margins of other conditions typical of social and cultural structure in own territory.
If urban areas are facing the consequences of de-industrialization and outsourcing, rural areas instead enjoy positive effects of location (in growing) in their territories of manufacturing firms and are no strangers to the development of certain economic tertiary activities (services to people tourism, "green payments" from renewable energy sources (OECD, 2009)).
Similarly, agriculture is undergoing structural and technical changes particularly important, not neutral in spatial terms (Vaggi et al., 2010). The rift between agricultural functionality and territorial functionality is now clear, it but does not reduce farming activities to activity without "territory." Not surprisingly, agriculture reduces their space progressively due to urban pressure for the sale of land for agricultural purposes and their use change; however, its productive specialization, not only agricultural, but multisectoral, allows the recovery of environmental , social and cultural functions.
It shows strong connections with natural environment and social component rooted in the community so as to pursue new activities: it defines boundaries, it acts as a protection of cultures, it holds smaller productions and protects biological corridor forms (biodiversity, riparian flora, differentiated fauna, Edge effect and connectivity, etc..). Then it contributes to the fight against erosion soil, it is land reserve and increases plant diversity, reduces pollution. At the same time, it mitigates impact of human activities on the land and contributes to the enhancement of historic roads and environmental and cultural resources. It is therefore always more multifunctional.
Rural areas are considered areas far from urban centers, systems of work or health services or assistance centers and not as areas lagging behind (Courtney P. et. al 2009). Similarly, there are custodians of traditional peasant values, but bearers of a new culture created to contamination with urban areas.

*The need territorial classification methods*

To reconstruct rural and urban territorial map is not methodological and conceptual exercise easy. The phenomena complexity involved in modification of territories and their social and economic dynamics makes difficult to reconstruct recent territorial logics and represent them in a not dichotomous way, but able to catch the spatial heterogeneity in an equal perspective, dignity and stress-free hierarchical tensions. However, this exercise is necessary for various reasons.

Support policies are built on the basis of territorial zoning. Classify an area as rural or urban could in fact understand (or exclude) a prerequisite for development, national and European interventions. Similarly, it could lead to a greater or lesser taxation of local income or the extent of any state transfers.

At the same time, it offers a new delimitation of territorial contexts, such as peri-urban areas, which would not be recipients of any specific policy.

*The methods of classification tested until now*

In the past, the commitment was to read the "large systems" (systems of cities or regions) that were described by a few indicators, such as concentration and population density, accessibility and land use, in various combinations according to statistical procedures. Rurality was defined by subtraction, as micro-community or agricultural area.

Today, the diversity of areas makes it difficult to arrive at a unique characterization of urban and rural policy and requires searching for more complex methods.

What is certain is that from an economic dimensional perspective (industrial or agricultural size) and mainly bipolar (urban-rural), it goes to a vision continues, but multi-dimensional, positioning of the territories between the two local extrema.

The subjective and often contingent character of hypothesis leads to multiple forms of possible representation. At national and international level, there is a definition of rurality (and urbanity) commonly accepted. To date, there are over 100 different methods of territorial classification (Cattivelli, 2012). Each country makes a partition of the land consistent with its social and economic dynamics; conversely abandon those that do not describe the full diversity.

| Analysis tecnique | Macrocategory classificatory | Country |
|---|---|---|
| Descriptive Statistics | For density population | Bulgaria, Spain, Cyprus, Germany, Ireland, Netherlands, Greece, Lithuania, UK, Estonia, Latvia, Luxembourg, Malta, Czech Republic, Romania |
| | For use of “green” criteria | |
| | For matrix of urbanization/land use | |
| | For analysis of social and occupational relations | |
| | For combination of demographic and economic methods | Spain, Poland |
| | For combination of demographic methods and characteristics of job market (commuting) | Belgium, Austria, Croatia |
| Spatial analysis | Accessibility to urban centers based on the method of distances | Switzerland |
| | Accessibility to urban centers based on the method of distance and concentration of population | Scotland, Catalonia |
| | Concentration / dispersion of the settlment with comparison of Built up / Not Built up | Finland, France, Germany, Sweden, Denmark, England and Wales, Ireland, Portugal, Norway |
| | Concentration / dispersion of the settlment with comparison of Land use | Netherlands |

**Table 1. The methods of classification adopted in the EU. Comparison of methods and spatial statistical methods. Source: reclassification of our survey, 2010-2011.**

Most of methods of territorial classification is constructed with techniques of descriptive statistics. The population density is the indicator most commonly used, followed by the green criteria such as the extension of forest and the economic ones such as GDP or per capita income. Especially recently,

spatial methods are very fashionable. They require the use of more complex of analysis techniques, but they are more precise in mapping the territory. They are based on distance calculation or on concentration / dispersion of the settlment.

*A new methods of territorial classification*

Testing of a new method of urban-rural classification is not easy.

In the identification of initial data, difficulties may relate to issues such as the different levels of upgrade, different possibilities of territorial detail and relevance with respect to the phenomena investigated. Subsequently, problems may relate to the choice of processing and representation of the data collected models.

The choices to be made are not simple and sometimes require taking very strong simplifying assumptions.

The process of selection and verification of basic information leading to select indicators that more than others describe the modern sense of urban development, such as high population density (European Union, DG Agriculture, 2010), strong attraction force work (European Union, DG Agriculture, 2010; Istat, 2011) and high consumption of soil (EEA, 2006; Gibelli, 2008; Bluffstone et al., 2008; Foietta et al., 2009).

In detail, the areas of greater degree of urbanization are also the most populated, though, record growth rates down noticeably (urban shirinkage, Schwarz et al., 2010); by contrast, the most rural areas are the most dynamic, but are by far the least populated (Eurostat, 2010).

In terms of employment, regional performances are different.

Urban areas are characterized by the highest concentration and diversification of economic activities and thus for the greater ability to generate jobs. They are able to exercise an attractive force towards local working population, including rural, and generate short and very short-range commuting flows (Eurostat, 2010). In the monocentric model of urban development, jobs were concentrated only here and the people chose the place to live by weighing the cost of housing, commuting and other factors (Alonso, 1964). Now, although the traditional suburb-to-center commuting is only a part of the more complex patterns because polycentric urban commuter creates multiple centers of origin and destination of commuting flows, rural areas are weaker for economic performance or ability to attract workers, especially skilled and young (Titheridge, Hall, 2006). Suburban areas are those that record inflows of more commuters (Naess, 2007).

Urban areas consume more land to meet the increased housing and settlement demand. Its satisfaction goes through the conversion of agricultural land or natural sites placed in the immediate outskirts of the city or, more recently, through practices of urban regeneration, regeneration projects of central or degraded or abandoned areas. Rural areas suffer instead of urban sprawl, they are shrinking because their extension, but because they are less densely populated, show lower values of consumption

The same process then leads to the exclusion of other indicators.

Do not include a description of agricultural indicators as an indicator is brave choice, but it is motivated by two very strong assumptions: the non-exclusive agricultural vocation of rural areas and the spread of agricultural practices in an urban contexts (eg: Ingersoll et al., 2007; Lanzani, 2007; Brenna, 2011).

Analysis of urban and rural differences for gender, age or level of education is not significant changes (DG Agri, 2009). Also the proportion of working population employed in agriculture or in industry does not show a lot differences between territories because of the aforementioned spaciousness of economic activities and non-exclusivity of vocational areas. Similarly, the amount of tourist flows is ignored because the most significant differences can be found at other territorial levels (Istat, 2010).

Although some researchers suggest to consider presence of bars, restaurants, taverns, cinemas or theaters or shops among the indicators (Skuras, Dimara, 2006), others prefer to ignore the provision of services to individuals or businesses, not only because of the difficulty of dealing with a substantial amount of data. It is known fact that the action of space to go to the favorite supermarket or own bank is almost identical to the inhabitants of rural and urban areas (Cattivelli, 2012b). The same

choices about the means of transport to move within this area are not very discriminating. Consider the car park or the number of tickets issued per year or the number of increased / decreased from means of transport is not only difficult because often the data is missing (not all municipalities have a train station, for example) or very expensive, but they are just indicative. The index of accessibility given by the number of municipalities within a day with a round/double trip is not very significant. The promotion of bike or car sharing initiatives or enhancement of transport projects are almost everywhere as a reduction in car use (even for short trips) excessive in both urban and rural areas (Istat, 2001, 2008; ASR 2009).

Family budgets and their components are not considered as discriminating factors of different territorial conditions due to the acceptance of equality between economic conditions of rural households and non-rural (Salvioni, Sciulli, Aiello, 2010). Even DG Agriculture (2009), Barberis (2010), confirm that there are no significant territorial differences in territorial distribution of income.

Demographic indicators are not considered because rural areas is not a concentration of single elderly people. It is true that these territories have both the highest dependency ratios and old age ratios (Istat, 2001, ASR, 20010, Eurostat, 2010), but it is also important to note that these values show noticeable declines in recent years as a result of demographic flows that satisfy the well-known theories of circularity (Finocchiaro, 1999). The demographic restructuring action is to be considered, but, at the same time, makes it more uncertain, or even negative, the use of indicators to measure it in territorial classification.

The inclusion of naturalness indicators is equally controversial. The extension of valuable agricultural areas or national parks could be misleading: not necessarily, rural areas have higher values of these ratios because, recently, even urban areas are equipping of green systems to mitigate the increased urbanization. Similarly, there are no studies that attest unequivocally higher values for rural areas (and therefore lower for urban areas) for the synthetic indices of environmental significance.

The same study of relative abundance of land policies on territorial differentiation is controversial. The increased provision of funding for certain regions is not only a sign of a more significant economic backwardness, but also of the greater editorial and local planning that leads to easier access to Community resources, and that is independent of territoriality.

The choice of territorial unit of reference is instead almost obligatory.

The town is almost optimal size for the survey. The province has an area too vast and often does not reflect the actual territoriality of economic phenomena; in contrast, the grid is basic unit to which they are reported only data on population density and the realignment of other data calculation requires complex procedures and the introduction of additional assumptions, sometimes too restrictive.

The techniques of data processing are numerous, however, it prefers the use of a method that is simple to understand and replicate in different territorial contexts, in line with the preferences of simplicity expressed in this sense by various international bodies (OECD in primis). Not surprisingly, we choose to produce a system of composite indicators obtained after a series of successive tests, using an innovative approach, DEA (Data Envelopment Analysis), a statistical method used in operations research. This approach is based on the establishment of a performance frontier with which each municipality is confronted in the process of construction of individual indicators and their subsequent aggregation from the municipal level. The composite indicator is in fact given by the ratios of the values of each municipality, respectively, compared to benchmark performance.

DEA was originally proposed to evaluate the performance microeconomic (Melyn, Moesen, 1991). It is able to handle many basic indicators simultaneously, can be used with any type of measurement and to analyze and quantify the sources of inefficiency. It allows to determine the relative efficiency of decision-making units in the absence of a detailed description of economic system of reference. It uses the values of each territorial unit by comparing its economy with all the possible savings from linear combination of observations of all municipalities. It originates then processes that can be solved by the application of an algorithm of linear programming for the weights determination. It does not require the definition of an objective function valid for all municipalities and leaves at each decision-making unit the possibility to balance the inputs and outputs so as to maximize their index

compared to the other units observed. It is completely "data driven" and "sensitive" to the priorities of national policy because weights are endogenously determined on the basis of observed performance.
For this exercise, these techniques are adapted for the construction of the composite through the introduction of a system of constraints and estimation of simple indicators.
This indicator is in fact expressed by a weighted sum of simple indicators relative to their benchmarks, namely:

$$IU_c = \sum_{q=1}^{Q} I_{cq} w_{cq}$$

**Equation 1.**

Where IU_c is the normalized index of urbanization, I_cq è the normalized value of q ^ th indicator q (q = 1, .... Q) for the municipality c (c = 1, .... M) and w_qc is the corresponding weight. The construction of simple indicators is the first step, not too complicated.
The population density is calculated by performing a quotient of the population detected by each municipality and their extension. The index of attractiveness for use instead is determined by dividing the number of in-commuters and total municipal population. In fact, the temporal asymmetry of these data affect the correct representability of the dynamics of local labor, but their use is obliged choice because there are no other latest data. Similarly, an appeal is made to the rigidity of the labor factor (for example, Blanchard, 1998, Blanchard and Wolfers, 1999).
Finally, use of land is studied . In particular, it is used an index of sprawl calculated as the ratio of the values of batch settlement and those relating to the extension of agricultural areas.
After building simple indicators, it is necessary to verify a correlation between them.
The correlation is calculated with the simplest calculation, Bravais-Pearson index,:

$$r = \frac{\sum_{i=1}^{N}(x_i - \bar{x})(y_i - \bar{y})}{N\sigma_x\sigma_y}$$

**Equation 2.**

Where x and y are the values of the indicators, x ¯, y ¯ are the average values, σ the covariance for the two indicators used. If r is low, it is possible to use these indicators.
The second step leads to normalization of the values of simple indicators according to the max-min method.
By way of example,

$$I_{qc}^{t} = \frac{x_{qc}^{t} - min_c(x_q^{t_0})}{max_c(x_q^{t_0}) - min_c(x_q^{t_0})}$$

**Equation 3.**

Cherchye et al., (2004), the first to implement this method, suggested obtaining the benchmark as the solution of a maximisation problem, although external benchmarks are also possible. The performance frontier is given, in our case, with the highest levels of population density, employment and attractiveness of urban sprawl because there is no common, at the same time, it is the most densely populated, the more attractive and more geographically dispersed.
It is therefore necessary to consider that:

$$IU_c = \frac{\sum_{c=1}^{M} I_{qc} w_{qc}}{\sum_{c=1}^{M} I *_{qc}\ w_{qc}}$$

**Equation 4.**

Where IU_c is the degree of urbanization of the municipality c relatively urbanization of others. The indicator IU_c must therefore be redefined with respect to the higher index achieved by a common, if they are assigned to all common weights chosen by the municipality c, in order to maximize its efficiency absolute. The maximum level of urbanization absolute reached by the municipalities considered, when the weights are used best for the municipality c, is then defined as follows:

$$I^* = I^*(w) = \left( \arg max_{I_{k,k} \epsilon \{1,\dots M\}} \sum_{q=1}^{Q} I_{qk}\, w_q \right)$$

**Equation 5.**

Where I * is the score of the hypothetical common that maximizes all the performance, given a set (not known) of weights.
The weights are determined specifically for each common and there is no common that boast the most weight in each indicator. The set of optimal weights (if any) provides the best placement for each municipality and is achieved by optimizing:

$$\left( IU_c = \arg max_{w_{qc}, q=1\dots Q} \frac{\sum_{q=1}^{Q} I_{qc} w_{qc}}{max_{I_{k,k\epsilon(1\dots M)}} (\sum_{q=1}^{Q} I_{qk}\, w_{qc})} \right)$$

For c=1…M and whit wheights not negative

**Equation 6.**

The respective values are the threshold value by which it is possible to realize the asset benchmark. Similarly, equation 6 can be reduced to a linear programming problem, multiplying all the weights by a common factor which will not affect the value of index and can be solved using an optimization algorithm.
Under the terms,

$$IU_c = \arg max_{wqc} \sum_{q=1}^{Q} I_{qc} w_{qc}$$

*s.t.*

$$\sum_{q=1}^{Q} I_{qk} w_{qk} <= 1$$

$$w_{qk} \geq 0$$

*For each k=1,…M; for each q=1,….Q*

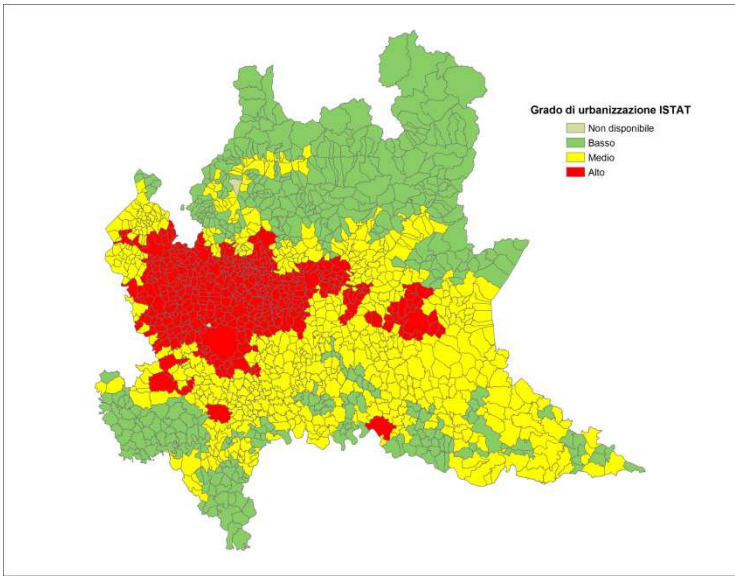
**Equation 7.**

The resulting composite index varies between 0 (low degree of urbanization) and 1 (high degree of urbanization).
This process is then repeated for each common thus obtaining an index of urbanization different and the related optimal weights that contribute to its determination, which, of course, differ for each municipalities. In fact, this allocation of weights can be a critical issue because the indicators calculated for the various municipalities are not comparable as result of various processes of deliberation. Similarly, municipalities that have high values of population density or sprawl can

"point" all about one of these indicators and thus be included among the urban municipalities. If, however, even by applying weights "favorable", the common gleans low values of urbanization, the judgment of "not urbanity" appears to be founded.
Then, the distribution of values are divided by quantiles. This operation is made easy through the use of GIS software. For the first test, only three quantiles are used, then four, then five, then six.

*The case study: Lombardy region*

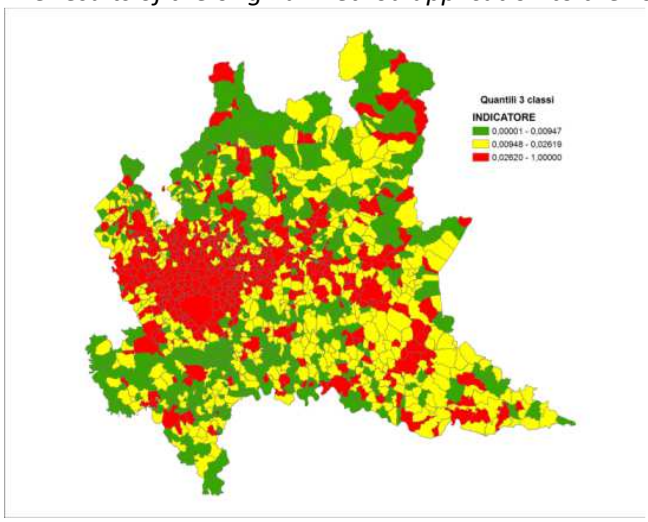
Lombardy Region is one of the four engines of Europe[1].


The Lombardy region is a densely populated area.
Nearly two-thirds of the municipalities have a population density of less than 500 inhabitants per km2. Only 5% has a density higher than 2000 inhabitants per km2 and, with the exception of the provincial capitals, are found mostly in the Milan metropolitan belt.
Overall, the whole zone Bergamo -Brescia-Milano is densely populated.
To the south of this area, there is a kind of transition zone, somewhat confused and divided, where next to cities with more than 500 inhabitants per km2, there are very small municipalities. Except for Pavia, Cremona, Mantova, in the extreme southern part of the region there is the largest concentration of common up to 200 inhabitants per km2. To the north, however, there are a lot of municipalities up to 50 inhabitants per km2.
It seems that the Lombard municipalities are self-sufficient from the point of view of employment: the non-resident population is in fact a small part of the overall employed. The reasons may be very different: lack of economic attractiveness or full employment at the municipal level. Perhaps, more properly, the root cause lies in the reduction of commuting. Lombard citizens prefer to move in the municipality where their workplace. Those who do not meet this condition are mostly in the belt of Milan or high economic growth rates municipalities due mostly to the development of local tourism.
It is clear that the region has a little dispersed settlement structure. In nearly 1,000 municipalities, discontinuous urban context is less than a third of the agricultural area. However, in the remaining ones, the values are very high. What is surprising is that the municipalities with the highest values of sprawl are not only found in the vicinity of urban centers of larger size, but also near the lakes or in more heterogeneous environment in the presence of different types of land.

[1] The others are: Baden-Württemberg, Catalogna and Rodano-Alpi.

*The results of the original method application to the Lombard context*



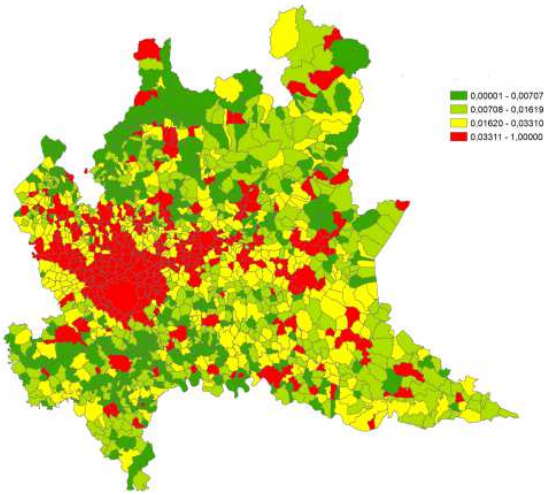



**Figure 1. The original method (left) and the proposed variation with four quantiles (right). Source: our elaboration on Istat 2011, 2001; Dusaf 2009, ASR 2011.**

Rural municipalities are 515. They have reduced spatial extent, but they are also very focused demographically, they are not "attractive" for employment and have a little dispersed settlement structure. They are therefore "dormitories municipalities" or "strongly residential" because a lot of the population resides in them, but works outside and residential development is quite controlled.

The most "attractive" municipalities among those in more rural areas are sparsely populated and are mostly in Milan belt. Perhaps, they are "passage municipalities" that is municipalities between most attractive economic centers that suffer of '"induced effect" for economic development, but not for the residential effects because they are too far away.

Rural municipalities have low rates of sprawl. 485 of them have values less than one. The remaining 32, however, have very high values and the extension of the discontinuous settlement is equal to four times the size of the agricultural areas. Of these, 30 belong to the provinces of Varese, Como and Lecco. They are municipalities located within very heterogeneous zones in which there are many peri-urban municipalities and will suffer the influence. They change their economic structure. In recent decades, these agricultural municipalities merely become tourist centers. Agricultural areas are reduced and the expansion of settlements, especially second homes, increases instead. However, this process is not concluded. The low index of commuting shows that the transition of the local economy does not end and that the tourism industry is still unable to produce more jobs than those required by the local population.

Rural communities are also present throughout Lombardy.

The provinces most "rural" are those in the south (Cremona, Lodi, Pavia, above) and in the north (Lecco, Varese, Como and Sondrio).

The province of Lodi is a little uneven and seems split at its main urban centers, Lodi and Codogno. At their extremes, it develops the areas of influence of Milan and Piacenza, which are also very heterogeneous due to the alternation of agricultural landscapes to those from strong industrial vocation. Pavia leaves between himself and Milan and Vigevano a sort of end of rural and peri-urban areas. Around the same Vigevano and Mortara, there are many peri-urban areas, but in the neighborhood of a close proximity, rural municipalities prevail.

The area of Milan is very urbanized, but it turns out that in the southern part peripheral urbanity is very small. The scattered presence of South Milan Agricultural Park is one of the causes of this spatial characterization. Varese, Como, Lecco and Sondrio have many rural municipalities located in the northern parts of their provinces. Around their main urban centers, urban regions are formed also widespread.The area between Sondrio and Lecco is special. To the north of SS38, in fact, there is a clear concentration of small municipalities by very low values of urbanization. At both ends and in the south, however, these municipalities are included among others, not much larger, but with higher degree of urbanization due to the greater urban sprawl.

The "peri-urban" municipalities have values of population density high enough (on average, about 350 inhabitants per km2), have a fair degree of attractiveness for employment (on average, about one in three workers does not reside in the municipality in which it carries on their profession) and land use (at an average km2 of land characterized by urban sprawl and productive three corresponding km2 of agricultural land).

Urban municipalities are more polarized. They are mainly in the province of Milan, Monza and Brianza and Lodi, in the neighborhood of Lecco, Varese, Brescia and Bergamo.

The provinces of Cremona, Mantua and Pavia are little urbanized. Among these municipalities, there are some with less than fifty inhabitants per km2 in province of Brescia and Bergamo, sparsely inhabited, but by high levels of commuting. The small urban municipalities are few, have high levels of commuting and sprawl, but they have not an economic purpose or a particular physical location. Their economies are heterogeneous and are dispersed. The average urban municipalities with a population density of between 150 and 500 inhabitants per km2 are also few, however, they show very high drop-out rates, well above the regional average. The large urban municipalities are almost concentrated in the

neighborhood of Milan and Monza, have a high degree of attraction ad suffer for pressures for the conversion of soil.
What happens if you change the class within which the rate of urbanization is shared? If you use four quantiles, then you will get four different territorial categories, such as the "urban municipalities" (in red), the "high degree of peri-urbanization municipalities" (yellow), the "periurban a low degree of urbanization municipalities" (light green) and the “rural municipalities" (in green).
Milan metropolitan area is high urbanized. The axis Bre-Be-Mi confirms its territorial heterogeneity and shows a suburban with a strong degree of urbanization. Province of Cremona is dominated by peri-urban areas: it is an area heavily subject to urban pressure. Provinces of Sondrio and Mantua areas instead show the presence of the weaker peripheral urbanity.
Rural municipalities of Cremona are mostly between the capital and Casalmaggiore. Between Cremona and Crema there are less. Those of Mantua are very few, only 5, but they are very closed to major centers. Their distinction is in fact based on small population, because their values of attractiveness and especially of sprawl are very high. In Brescia, they are in the proximity to urban centers. They have a low population density and are less attractive than others included in the same category. However, they have sprawl values by too much variability between them, there are municipalities with extreme values much higher than the category average or close to those experienced by urban municipalities. In the east, province of Sondrio is rightly little rural, but a lot of rural municipalities are subclassified for their intensity values of diffusion settlement and they could find space between the peri-urban areas from low-grade or high degree of urbanization. The rural population, however, is well mapped, but maybe around the border with the province of Lecco, there is a greater degree of urbanization.
In the neighborhood of Bergamo, rural municipalities insist but they also should be classified differently. The southern part of the province of Como has almost no rural municipalities, the northern instead seems to be dominated by these municipalities (in the province up to 55) that have values of population density consistent with those of class, low levels of attractiveness for employment, but values of indices of sprawl far superior to those of periurban municipalities from higher urbanization. The province of Milan is almost devoid of these municipalities (there are 4) and their values are almost identical to those of the class. The rural municipalities in Varese province are very populous, more than the regional average, they have low levels of attractiveness, but high levels of intensity of land use, often far superior to one. The rural municipalities of Pavia are many, perhaps too many. In the neighborhood of Pavia, Mortara, of Vigevano, the high values of some of the indicators suggest a zoning of higher rank, at least to a condition of slight peripheral urbanity
Among them, there are all provincial capitals and municipalities with more than 30,000 inhabitants. For the most part, they are in the range Brescia-Bergamo-Milano.
In this south-west area in the province of Milan, municipalities tend to combine with each other. Open spaces are scarce. The indices of sprawl and the population density are very high. Because some of them are not compact because they are only partially attached to the context, it might be more appropriate to consider suburban municipalites whith high degree of urbanization.
In Varese province, there are some that have more than 2,000 inhabitants per km2, or have values of simple indicators even double those provincial average. A similar problem also applies to those in Como. Perhaps, for both provinces, it would be appropriate to distinguish more clearly the distribution in peri-urban and urban areas, considering the apparent variability in common they contained.
However, in general, the classification is consistent and correct.
The mapping is altogether positive.
Technically, the method is good, serves to better detail the suburban areas, however, finds a few rural areas and sometimes "overestimation" bigger towns.

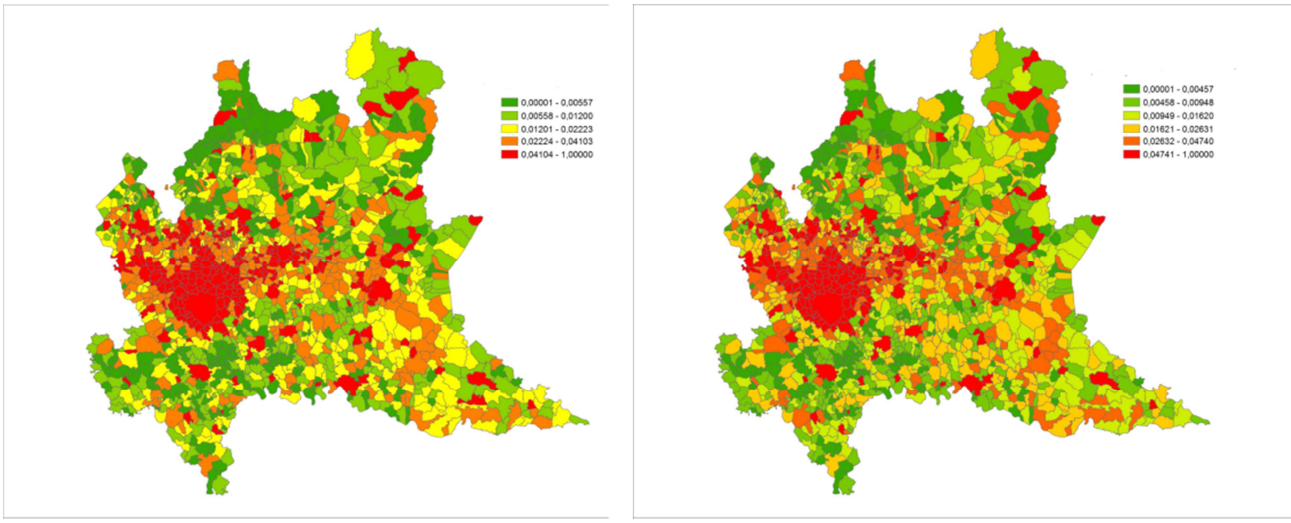



**Figure 2. The zoning with the DEA method with five quantiles (left) and the proposed variation with six quantiles (right). Source: our elaboration on Istat 2011, 2001; Dusaf 2009, ASR 2011.**

In the five quantiles examples, the more rural areas have a low population density, a reduced degree of attractiveness and are soon scattered throughout the province. Primarily, they are small or very small municipalities, sparsely populated or highly concentrated, self-sufficient and less attractive from the point of view of employment, located in the mountainous areas of the northern provinces of Lecco and Sondrio or in the area between the north of Cremona, Lodi and Pavia north (well 73). It is not surprising that only a few kilometers from Milan, there are some of the most rural municipalities. It is peculiar that there are very few "more rural municipalities" in the province of Mantua, that with Cremona, Lodi and Pavia, represent the most rural provinces.

22 are located in the Province of Varese, 48 in Como, 40 mostly in the northern part of Bergamo province.

It seems that they have disappeared in the lake vicinity. Periurban municipalities with a low degree of urbanization are not a new category; however, they record different values in simple indicators and in that complex. The population density is higher than the national average; their attractiveness for employment is almost double that of rural municipalities, while the index of sprawl is lower.

They are in fact a bit larger rural communities and they are often in the first belt of the provincial capitals. It applies to Cremona, Sondrio, Pavia, Mantua, where outside the municipal boundaries there are sparsely populated areas and scattered throughout the territory. It does not apply to other capitals instead that are surrounded by municipalities from increased urbanization. It also varies their territorial distribution: they occupy mostly the entire eastern part of the province of Sondrio, they dominate the north of Bergamo, they wedging in the areas of the highest urbanization of Bre-Be-Mi and make their appearance at the lake areas (in wrong) and medium Mantua (with reason).

Periurban municipalities with average degree of urbanization, except for population density and for employment attractiveness, have values that do not differ much from those of municipalities with lowest degree of urbanization. The differences lie in their more populous and in their economic diversification, which makes them more dependent on workers who reside in other municipalities. The index of sprawl is of very little higher. Perhaps, these municipalities are affected by little conversion processes of the soil or its extent is still insignificant compared to the total municipal area or are very limited.

It is right the qualification for municipalities of the middle and high Mantua or for those on the border with Cremona province.

The peri-urban areas by average degree of urbanization are mostly in the medium and in the high Mantua, in the south Cremona, in the southwestern part of Milan province and at the ends of Bre-Be-Mi band. Those of Varese have a density of population very high, higher than average for the category but they are included here because they have low values of attractiveness for use. Those of Como are rightly included here not only because they have a population density almost identical to that of other

towns of the class, but because they have lower values of urban sprawl. For these values it does not make sense to consider them, as do other zoning, rural or peri-urban areas as a low degree of urbanization. Even those of Lecco are well mapped affected not only because of anthropogenic pressures, but also those of the surrounding naturalness which restricts the settlement.
The population density is twice as municipalities of average degree of urbanization, even three times larger than those from the low degree of urbanization. This indicator, along with the index of sprawl rise a lot, the rate of urbanization. Overall, it is mostly common for municipalities in the vicinity of the main urban centers, not only capital, and it is highly susceptible to erosion of free space.
The attraction index is slightly higher and concentrated which means that the commuting phenomenon is almost absent and that, perhaps, the greatest urban sprawl is also caused by increased residential demand or the first relocation of some firms. Those from the highest degree of urbanization, instead, are mostly included in the central area of the region. They are almost absent in the extreme northern and southern provinces.
Despite this shortcoming, the distinction between this class and the urban communes is very positive, otherwise some municipalities with the higher degree of urbanization would be included only in the peri-urban areas, despite boast over other values sprawl and population density much higher (between the common category of the lowest value and the highest there is a difference of more than 1,500 inhabitants, while the index of sprawl is slightly less than 0.5); vice versa, some municipalities may be considered urban despite having a value indicator urbanity modest. Both of these conditions affect the municipalities of upper and middle Mantua which would otherwise be poorly mapped. They are better mapped also municipalities in the south of Mantua, especially those located on the border with Emilia Romagna. Even those places along the Cremona-Mantua, thanks to infrastructure development and trade, are considered by the higher degree of urbanization. A lot of municipalities of Pavia are then promoted to a higher degree of urbanization. Their inclusion in the urbanized central bands in the range immediately to the north, where instead insisted municipalities classified in the same way in Milan is correct. The south municipalities are more fragmented because they are included among those with the lowest levels of urbanization, but thery are equally well represented. Even Codogno is well mapped: it is too small for population concentration to be defined as rural, despite boast density levels for land high. The area between the Parco Nord Milano is well represented: the degree of urbanization is high, but it is partially mitigated by the presence of this green area. To the north, it is just that they are few, and those present are mostly in the mountain or tourist towns.
Finally, urban communes are all municipalities with more than 30 000 inhabitants and for the most part included in the provinces of Milan and Monza Brianza. There are also near Bergamo and Brescia. The distinction between peri-urban and urban with high degree of urbanity is everywhere positive because it captures the different levels of local urbanization.
Their values are twice the previous category. Their high value of sprawl index denotes the strong development pressures to which these areas are subjected.
In the six quantiles, “ruralissimi” municipalities values are almost identical to those recorded for the rural municipalities in the previous classification. Their population density and their attractiveness for use are very low. Sprawl index, for the category, is very high, so as to be equal to that detected by the peri-urban areas by the low degree of urbanization.
They are mostly scattered in the north and south west of Sondrio province, in the northern part of Lecco province and north of Pavia. Lodi is confirmed as rural province, because in the continuum between Codogno and the capital there is the greatest concentration of ruralissimi municipalities. There are not in the provinces of Cremona and Mantua, where, according to other classifications, the rural is an essential feature of local landscape.
Rural municipalities have a population density slightly less than the national average. Their other values, except for the index of attractiveness for employment, are almost identical with respect to those recorded by rural municipalities identified with the use of five quartiles. These municipalities "attract" more commuters, but they are equally dispersed in the territory (due to the presence of common lacustrine this value remains high). The index of urbanization, however, is three times higher.
They are mostly in the neighborhood of Mantua, or in Brescia, in the second or third band from the capital and they settle in the central area of the highest urbanization. They prevail in the strip of land

between Lodi, Milan and Pavia, and in the western part of the province of Pavia. They are absent in the province of Monza and Brianza.
The peri-urban areas by the low degree of urbanization show marked differences compared to the rural communities in particular as regards the population density and attractiveness for employment. In fact the high values of these indicators that determine a higher index of urbanization. Their index of sprawl is the lowest of rural municipalities and very little higher than that recorded for the "most rural municipalities".
These areas are mostly found in Mantua and in the northernmost areas of Bergamo and Brescia provinces. There are also present near Lombardy lakes.
The peri-urban areas by average degree of urbanization are clearly distinguishable from municipalities with low degree of urbanization from peri-urban and rural areas. They record around twice for each indicator. All intervals are very high. They are in fact very populated, but at the same time, the population is dispersed throughout the territory, very urbanized. They have a robust economic structure so as to attract workers living in other municipalities. Maybe that is the most attractive employment to induce greater conversion of agricultural land for residential use.
The degree of urbanization from peri-urban areas also represent a category of municipalities with a clear identity values. Their values are very high, close to those recorded for urban municipalities.
These municipalities dominate Bergamo, Brescia and Milan provinces. Some of them are the most touristic places in the region.
Finally, urban municipalies have highest values of all indicators and are concentrated in a fee areas.

*Conclusions*

Today, urban and rural territories are very complex. Among them, there are relationships, also very complicated, that find in the periurban areas their most obvious expression. Their understanding is important because it helps policy makers to implement correct policies of territorial development. To do this, it is necessary to implement a correct zoning methods. There are a lot of methods, however, they are complicated or do not represent correctly territorial heterogeneous. The new method is simple.
Preference shall be technique in the direction of simplicity, both for the choice of indicators both for the survey technique. DEA methods is not complicated because it reduces the analysis to a linear programming problem. Its three indicators, population density, sprawl index, attractiveness index are easy to build. The quantile choise is more complicate. Three quantiles model is adoptable, if it is necessary to minimize the difficulty of results interpretation. Four quartiles model is already more detailed because it wants to distinguish, with greater detail, the periurban areas, according to different degrees of urbanization. Five quantiles model has the same goal, however, for some of the identified quantiles you notice differences such as to justify the distinctions in such a large number of classes. The same is not true for the last performance, six quantiles model, where rural and peri-urban areas as a low degree of urbanization do not differ so significant as to warrant their distinction.
In addition, representation quality counts. Representation with three quantiles is a bit generic but simple and intuitive, the one with six quantiles is more detailed. Those with four and five quantiles are the best because they take more intensely territorial diversity. Four quantiles model is periurban-centric, but generalizes the peri-urban areas that have a greater or lesser degree of urbanization and pulverizes the city between heterogeneous contexts. Five quantile model is the best representation for suburban areas and highlights more gradation and their importance in highly urban and highly rural areas.
For all these reasons, zoning with five quantiles seems to be more consistent, but it is not possible to exclude the one with three.

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