

Quality Agro-Food Districts, typical Products, local Governance

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Abstract - The paper investigates the coexistence of different organisational patterns of local productions and evaluate which local governance may be more appropriate in a globalized agro-food scenery. We analyze, through the spatial analysis tools and the use of suitable indicators at municipality level, some PDO/PGI products in two Italian regions, Veneto and Emilia Romagna, which adopted very different strategies. The regional institutions in Veneto preferred to individualize "from the top" the quality agro-food districts at provincial level. In Emilia Romagna, instead, the policy makers decided to recognize the initiatives from the "bottom", born through various types of agreements. The spatial analysis allows to select the most appropriate indicators in order to identify homogeneous local systems, reducing the complexity of the issues to be addressed in the definition of their geographic boundaries. The results of our analysis allow to evaluate these approaches, highlighting the strengths and weaknesses of two different models of the agro-food districts. The purpose of our comparison is not to suggest the best model to be transferred to other regions, but rather to assess whether the regional strategies are appropriate to the specificities of their territories.

1. INTRODUCTION

The paper is focused on the coexistence of different organisational patterns of local productions. The goal is to evaluate which

local governance may be more appropriate in a globalized agro-food scenery.

The study starts from some general considerations:

- The identification of a PDO/PGI product (EEC Regulation 2081/92) is the result of a choice of various actors, contributing to its production and consumption. The relationship between specification and development falls not only on technical criteria, but also on the relations between producers and consumers, which represents the base of the recognition. These relationships, that imply different levels of coordination among producers, have a direct effect on the inclusion or on the exclusion of certain territories. Generally the definition of the geographic boundaries in the Code of practises is the result of a difficult negotiation process in which many different stakeholders are involved. Political local institutions are interested in reaching a wider area, while producers would like a smaller one. The excessive enlargement of a production area would lead the "historical" producers to compete with non-traditional producers. As a consequence the following question naturally arises: which is the right criteria to be used when defining a production area?
- In Italy, the DL 288/2001 introduced the tool of the agro-food quality districts, delegating the criteria for their identification to the Regions. The central requirement for their identification is represented both by the presence of one

Accordingly, at regional level it may exist more institutional areas, with different degrees of protection and different strategies.

- The key element is thus represented by the efficiency of the territorial governance for promoting new patterns of competitiveness in world markets and for fostering the rural development. If the attention raises on PDO/PGI products, regional policies should focus on the territory, through an integrated programming, formal or informal, with a strong involvement of all public and private stakeholders. Nevertheless the problem of the correct spatial reference for the construction of efficient patterns of governance for the production area is not solved. If the focus is placed on quality agro-food districts, it exists the trouble of the efficiency of the new institutional level and mainly the risk of not defending some PDO/PGI products.

In the light of these considerations, we shall investigate two Italian regions (Veneto and Emilia Romagna), which adopted very different strategies. In the case of Veneto, the regional institutions preferred to individuate specific agro-food quality districts: the Prosecco district (Treviso), the horticultural district (Verona), the wine district (Verona) and the dairy district (Treviso). The boundaries of these districts, defined at provincial level, do not highlight the real needs for public intervention in PDO/PGI areas. This approach can be defined as "approach from the top". In the case of

Emilia Romagna, instead, the regional policy makers have decided to do not create a new institutional level, while recognizing the importance of the aggregation tools through various types of agreements. This led to the birth of two initiatives from the "bottom": the "Association for the district of processing tomatoes" and the "Agro-Food district of Parma Ham".

In our work, in both regions, through the spatial analysis tools and the use of appropriate indicators at municipality level, we shall investigate some PDO/PGI products. The spatial analysis allows to select the most appropriate indicators in order to identify homogeneous local systems, reducing the complexity of the issues to be addressed in the definition of their geographic boundaries. The results of this analysis allow to evaluate the approaches used by the two Regions and highlight the strengths and weaknesses of two different models of the agro-food districts.

2. THE AGRO-FOOD LOCAL SYSTEMS IN ITALY

2.1 *The open questions*

Since the early nineties, the Italian agricultural economists explored the complexity and heterogeneity of the Italian agro-food system by borrowing concepts and instruments from industrial economics, including that of "industrial district", proposed by Marshall (1966). Only in a first approximation the globalization, with which the agro-food system is comparing, involves a weakening of the importance of the territories; indeed it emerges the relevance of concentration and specialization of agro-food production, closely related to socioeconomic contexts where processes are falling. In other words this highlights the importance of spatial dimension, seen as the specific endowment of tangible and intangible resources, as well as the socio-economic

subjects and local institutions (Alfano, Cersosimo, 2009).

In the same direction the international research has developed the concept of SYAL (Localized Agro-food Systems), i.e. "production and service organisations (agricultural and agro-food production units, marketing, services and gastronomic enterprises, etc.), linked by their characteristics and operational ways to a specific territory. The environment, products, people and their institutions, know-how, feeding behavior and relationship networks get together within a territory to produce a type of agricultural and food organization in a given spatial scale" (Muchnik and Sautier, 1998). Also this definition refers to industrial districts, to the concept of territory as "a developed space, socially constructed, culturally labeled and institutionally regulated", to territoriality, as the "feeling of belonging to a territory" (Tizon, 1996) and to references identifying "sensitive and memorial bases".

In Italy the interest for the districts led to the adoption of DL 288/2001, which introduced the agro-food quality districts, delegating to regional institutions their definition and individualization. It should be remembered that the legal definition of agro-food quality districts seemingly refers to the PGI and PDO products, since they lie outside the negotiated planning and have the purpose to exploit the territory and the quality products. This means, as a negative effect, that in the territories characterized by a concentration and specialization of agro-production, in the absence of certified PDO or PGI products, the existence of the district might be denied. However the doctrine highlighted that the obstacle could be overcome by considering the certification of quality, rather than a premise, as an objective that the district must reach once established.

Despite the Italian evidence of numerous situations that could lead to agro-food districts, only 6 regions have introduced this tool in their legislative framework (Piemonte, Veneto, Lazio, Calabria, Abruzzo, Sicilia). In addition, the experiences gained have shown a lack of projects, with a limited number of approved agro-food districts (only 9). The lack of a clear legislative framework on the conflict of powers between State and regions has certainly weighed on this delay. First, the territories in degree to put in place processes for self-construction of the districts, were blocked by the lack of comprehensive legal instrument or by the regional inertia; secondly there was the inability to use the opportunities of fiscal and financial measures (exclusive for the districts), with serious repercussions for the local system and for the whole country. As a consequence, for facilitating the introduction of the agro-district in the Italian scenery, in december 2008 the EU Commission has agreed to the granting of State aids for the implementation of contracts for "filières" and for "districts" (referring to DL 2850 of April 2008).

Behind the failure to implement agro-food districts it should be stressed that regional defaults clashed with other problems. While there was the need to promote and sustain the bottom-up territorial projects, there were many difficulties in providing tools to local public and private institutions to define the most appropriate geographical areas for the eligibility of agro-food districts, given the need of not creating new institutional subjects, as well as existing ones. In regional territories it may coexist both regional integrated projects, both local action groups (LAG) under the LEADER approach, both PDO and PGI products, whose geographical limits contained in the single Code of practises sometimes is larger than the most

suited areas. In these cases the purpose of public and private institutions is, at different levels, the territorial development, through implementation of sectoral (filieres contracts) and territorial policies (typical products and LEADER).

This is the background to our investigation in two regional situations (Emilia Romagna and Veneto), although we are aware that the use of official statistical data in our investigation can simply divide the local systems in areas with district vocation or not. As highlighted by Brusco and Paba (1997), "if really these local systems are equipped with a system of rules, codes and institutions to set up a district and if in this system local external economies play an important role, it remains to be investigated. This will be task of the empirical analysis conducted with instruments that comes not only from economic theory but also from other disciplines such as sociology, geography, history or anthropology".

2.2 Comparison between two regional models: Veneto and Emilia Romagna

Before to analyze the spatial dimension and to evaluate the agro-food district experience in the two regions, it is necessary to briefly analyze their different regulatory framework for the local development . The purpose of the comparison is not to suggest the better model to be implemented to other local contexts, but rather to assess *ex-post* whether the strategies are adapted to the specificities of their territorial dynamics.

Messina (2005) sustains that the ways to regulate the local development in Veneto and Emilia Romagna differ in some key variables:

- the style of local government (non-interventionist in Veneto, interventionist in Emilia Romagna);
- the nature of public policies (distributive in the first case, redistributive in the second one);

- the structure of enterprise networks (informal, short and closed networks in Veneto, long and open in Emilia Romagna);
- the social construction of territory (in Veneto a more marked contrast between city and countryside exists while in Emilia Romagna there is a better integration);
- the design of policy, characterized by an "anti-statism communalism" in the first case and by the "municipality" in the second.

These different ways of regulation of local development were also reflected in the agro-food system, when in compliance with law 288/2001, regional institutions identified and defined the boundaries of the quality districts.

In Emilia Romagna, in line with what happened with the industrial districts, since the mid-nineties (LR n. 47 of 1995), facing the challenges posed by globalization, regional institutions have focused on the creation of Centres of services, mainly addressed to the transfer of new technologies and to the provision of specialized services with high value added. It deals of consortium institutions whose primary function is to facilitate the process of outsourcing for small and medium-sized agro-food firms, largely present in the region. This policy, result of a strong interaction and planning between public and private actors at local level, was one of the reasons that led to the rejection of a fixed framework definition. In addition, the rigidity of the definition contained in the district legislation, the plurality of types of local systems (sectoral clusters, linkages in supply chain, quality districts), but also the conflict of powers between State and regions, mentioned before, led Regional institutions only to recognize agro-food districts that were promoted by the bottom

from the local realities (Parma Ham, Tomato Industry).

Veneto followed a different path. In this context services to enterprises are always provided by a range of stakeholders (professional associations, Chambers of Commerce, etc.); the services are mainly for administrative and fiscal adjustment in regulations and in certification quality. In this region the demand for strategic and innovative services, such as those relating to training, innovation, research and development, is poor; firms prefer to find themselves new paths to address the growing internationalization agribusiness. Furthermore, the regional institutions have pursued rather than a local development policy, a mainly sectoral one, through the provision of funds implementing EU policies, agreeing actions with trade associations and with the larger firms. The difficulty of regional institutions to intervene in local contexts was also manifested in compliance with law 288/2001, which led to the simple identification of 4 agro-food districts at the provincial level (Prosecco Valdobbiadene - Treviso, Fruit and Vegetables - Verona, Wine - Verona, Milk Dairy - Treviso), which still remain without a practical application. In fact both the elements for their recognition and for their management were not specified, demanding such material to further measures.

3. THE METHODOLOGY

The path analysis followed in both regions consists in two stages, both focusing on the spatial data analysis. In the first phase the aim is to identify the main macro-regional systems, with quite homogeneous characteristics in a rural profile, because the indicators refer to the social and economic context and to the primary sector. Within these regional systems we will identify local agro-food systems, districtual or not,

focusing on the presence of PDO and PGI, to understand how and in which measure the present dynamics of each area can affect the productivity of the sector, constituting elements of competitiveness or crisis, but even if the geographical boundaries of the PDO product specification matched to the most suited areas.

In the second part the focus is only on the agricultural specialization, taking into account some PDO. In particular, we deal about dairy products in Veneto, Asiago cheese and Montasio cheese and Parma Ham in Emilia Romagna. In the study we use indicators at the municipal level, estimated using the Census of Agriculture (2000), the Census of Industry (2001), the FADN Standard Gross Margin (average 2003-2005) the 2005 Value Added and employment (Istat, *Sistemi Locali del Lavoro*) and the 2005 data for population (Istat). The estimation of SGM at the municipal level was made only for main agricultural production (crops and livestock) in both regions. In the first phase, for zoning the regions, the results of which are described below, we used a procedure based on two stages: in the first, through Geographically Weighted Regression (GWR) (Fotheringham *et al.*, 2002), we estimated parameters that explain the diversity of the SGM per hectare of UAA at the municipal level and in the second, a cluster analysis¹, we proceeded to the grouping of the municipalities according to the similarity of the values of the parameters estimated by the GWR.

To explain the variability of the local SGM per hectare of UAA, and to identify the main territorial systems in the realities of both regions, sufficiently homogeneous under rural aspect, assuming that the SGM/UAA can be an acceptable proxy of the index of rural development, we used the indicators

¹ MCLUST (Fraley, Raftery, 2006).

given in Table 1. The main results of the GWR models can be seen in Tables 2 and 3.

Table 1 – Municipal indicators

Indicator	Description
SGMUAA	Standard Gross Margin (SGM) per UAA
GVAPCA	Per Capita Value Added
GVAAGR	Agricultural Value Added (% on total GVA)
GVAIND	Value Added in industry (% on total GVA)
GVASER	Value Added in services (% on total GVA)
EMPAGR	Employment in agriculture (% on total emp.)
EMPIND	Employment in industry (% on total emp.)
EMPCSER	Employment in services (% on total emp.)
UNEMP	Unemployment (% on active pop.)
DENSPOP	Population density (inhab/km ²)
AGEING	Ageing index (pop. >=65/pop. 0-14)
FARLT5	Farms under 5 ha (% on total Farms)
FARAB50	Farms above 50 ha (% on total Farms)
UAALT5	UAA of farms under 2 ha (% on total UAA)
UAAAB50	UAA of farms above 50 ha (% on total UAA)
CEREALS	SGM cereals (% on total SGM)
HORTI	SGM horticulture (% on total SGM)
FEEDCROP	SGM feeding crops (% on total SGM)
PASTUR	SGM pastures (% on total SGM)
FRUITS	SGM fruits (% on total SGM)
WINE	SGM vineyards (% total SGM)
OLIVE	SGM olive oil (% total SGM)
BOVINE	SGM bovine (% total SGM)
PIGS	SGM pigs (% total SGM)
SHEEP	SGM sheep (% total SGM)
EQUINE	SGM equine (% total SGM)
POULTRY	SGM poultry (% total SGM)

The standard gross income per hectare was related respectively with the Per Capita Value Added (*GVAPCA*), the Services Value Added on total GVA (*GVASER*), the unemployment rate (*UNEMP*)², the density of the population (*DENSPOP*), the ageing index (*AGEING*), the incidence of farms with up to 5 ha of UAA (*UAALT5*), the Standard Gross Margins of cereals on total SGM (*CEREALS*), the incidence of horticultural products (*HORTI*), feeding crops (*FEEDCROP*), vineyards (*WINE*), fruits (*FRUITS*) and pastures (*PASTUR*), while livestock production are represented to

² Only in the Veneto estimation

bovines (*BOVIN*) and pigs (*PIGS*), always as a percentage of total SGM.

To test the stationarity of the parameters we used the F3 test developed by Leung *et al.* (2000); the results are summarized on the last column of tables 2 and 3.

The Pseudo-F value is significant in both estimates, indicating that GWR is the appropriate choice (Brunsdon *et al.* 1999). The models have a high value of R²; its global value is 0,960 (0,700 estimate with OLS) in the case of Veneto and 0,927 (0,680 estimate with OLS) in the case of Emilia Romagna. The comparison between the residuals in the OLS and GWR estimates confirms the significant gain in efficiency achieved by the GWR approach in comparison with OLS.

Table 2 – Veneto: main GWR results

Variable	Min.	1st Qu.	Median	3rd Qu.	Max.	Stazionarity
INTCP	-19212.25	4808.05	7327.76	9207.69	283611.16	N
GVAAGR	-1.25	-0.02	0.03	0.13	2.84	N
GVASER	-887086.33-5258.92	-1628.24	306.06	21932.99		N
UNEMP	-473782.82-192.89	85.55	585.55	10025.82		N
DENSPOP	-3.48	-0.13	0.31	0.96	6.41	N
AGEING	-1874.05	-332.61	-24.52	216.77	1908.95	Y
UAALT5	-6318.91	-969.13	-118.55	494.78	4496.96	N
CEREALS	-33137.65	-15773.12	-12055.64	-8977.80	2965.99	N
HORTI	-44647.44	-4318.12	-518.39	988.20	12989.38	N
FEEDCROP	-21015.85	-5702.07	-2373.95	2143.20	42534.33	Y
WINE	-15387.21	-6611.55	-4964.47	-3035.28	28215.48	N
FRUITS	-22939.55	-3657.79	-2494.46	-1085.72	3634.61	Y
PASTURE	-86963.24	-17033.47	-12499.56	-9088.72	123232.48	N
BOVINE	-10977.31	-2331.79	-814.79	455.84	3897.97	N
PIGS	-6970.24	-1727.86	-557.17	1896.44	23907.10	Y
R ²	0.787	0.918	0.942	0.963	0.991	-

Adaptative bandwidth: 69/580

Aic: 9377.823

Rss: Ols 740507563.0; Gwr 99001832.9

Pseudo-F = 10.930, p-value < 0.001

With the exception of *AGEING*, *FEEDCROP*, *FRUITS*, and *PIGS*, all the estimated parameters are not stationary in the case of Veneto, while only *AGEING* is stationary in Emilia Romagna. The presence of non-stationarity is reflected by the

presence of groups of municipalities, with spatial contiguity, that have similar values of the parameter, namely, with the value of the parameter that is statistically significantly correlated to the geographic location of the municipality. If the parameters would be stationary their values would tend to be randomly allocated with respect to the location of the municipalities.

Table 3 – Emilia Romagna: main GWR results

Variable	Min.	1st Qu.	Median	3rd Qu.	Max.	Stazionarity
INTCP	-2987.00	186.60	3156.00	7837.00	13320.00	N
GVAAGR	-0.17	-0.02	-0.01	0.01	0.15	N
GVASER	-36.88	-11.91	-1.75	15.58	54.49	N
DENSPOP	-0.72	-0.27	0.12	0.27	2.41	N
AGEING	-973.70	-105.40	-11.50	74.70	806.40	Y
UAALT5	-63.47	-6.94	12.56	31.98	60.14	N
CEREALS	-36080.00	-15260.00	-7673.00	-712.60	5316.00	N
HORTI	-6505.00	-566.30	1213.00	5516.00	11840.00	N
FEEDCROP	-23840.00	-6088.00	-1833.00	837.60	12300.00	N
WINE	-9090.00	-4937.00	670.20	4093.00	9222.00	N
FRUITS	-7420.00	-1438.00	1328.00	4710.00	17550.00	N
PASTURE	-62420.00	-17460.00	-8134.00	-2235.00	8464.00	N
BOVINE	-15980.00	-4585.00	2281.00	5495.00	10290.00	N
PIGS	-5899.00	552.60	5708.00	9531.00	14490.00	N
R ²	0.848	0.887	0.908	0.935	0.974	-

Adaptative bandwidth: 85/341

Aic: 5325.179

Rss: Ols 361580417; Gwr 90658591

Pseudo-F = 6.1579, p-value < 0.001

The second phase, the research of the specialized systems, was also conducted in two phases:

- in the first step we use a spatially constrained multivariate analysis method (multispati-pca, Dray *et al.*, 2008), which is a generalization of Wartenberg's (1985) Multivariate Spatial Correlation Analysis (MSCA)³. This technique implies a compromise between the relations among many variables (multivariate analysis) and their spatial structure (autocorrelation);

³ See Appendix.

- in the second step we submit to cluster analysis⁴ the results of multispati-pca to verify the presence in the region of territories with similar characteristics.

In Veneto we used the following variables (table 4): GVAAGR, AGEING, UAALT5, UAAAB50, FEEDCROP, PASTURE, BOVINE, A155, while in Emilia Romagna we used GVAAGR, AGEING, DENSPOP, UAALT5, UAAAB50, BOVINE, PIGS, A15111, A15112, A15130. The results of the second phase of the analysis are described in the following paragraphs.

Table 4 – Indicators used for the detection of local specialized production systems

Indicator	Description
GVAAGR	Agricultural Value Added (% on total GVA)
UNEMP	Unemployment (% on active pop.)
DENSPOP	Population density (inhab/km ²)
AGEING	Ageing index (pop. >=65/pop. 0-14)
UAALT5	UAA of farms above 50 ha (% on total UAA)
UAAAB50	UAA of farms above 50 ha (% on total UAA)
FEEDCROP	SGM feeding crops (% on total SGM)
PASTUR	SGM pastures (% on total SGM)
BOVINE	SGM bovine (% on total SGM)
PIGS	SGM pigs (% on total SGM)
A15111, A15112, A15130	Meat Industry (beef and pork): Employees/Local Units
A155	Dairy Industry: Employees/Local Units

4. THE AGRO-FOOD DISTRICTS IN VENETO

In this region, the first part of the analysis was previously conducted by Montresor and Pecci, (2010) and here the main results are shown. The spatial analysis allows to find out some main systems (Figure 1 and Table5):

A) *The large metropolitan area characterized by industrialization and high population density.*

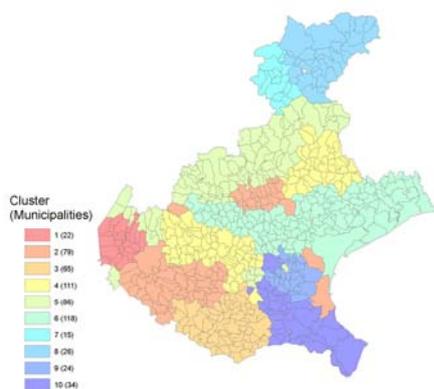
- *The metropolitan system with different agricultural specializations (cluster 6).* Although the primary sector does not

⁴ See note 2.

play an important role at local level neither for employment nor for income, the contribution of these areas to the regional agricultural productivity is high (almost 25% of total Agriculture Value Added). The production systems are very diversified: livestock (almost 28% of regional bovines, more than 30% of pigs and 24% of poultry), cereals (almost 28% of total cereal UAA) and wine (over 24 % of total wine-growing areas), often of considerable quality;

- *Highly intensive systems with a medium level of socio-economic development (cluster 2).* Especially in this large share of the metropolitan area of Veneto, we can detect the higher agricultural employment (25%), with over 24% of Agriculture Value Added of the region. The role of the primary sector is also relevant for territorial development given the high integration with the food processing industry, with over one third of total employees. The livestock systems are prevalent with nearly 32% of bovines and 29% of pigs on total regional amount;
- *Systems with high population density and extensive agriculture (cluster 9).* This is a small proportion of the metropolitan area, where employment is mainly focused on the services sector.

Figure 1 - Veneto: main regional systems



B) Mountain systems with different levels of socio-economic development and agricultural productivity.

- *Mountainous and hilly areas with an average level of agricultural development (cluster 5).* In mountain areas with low agricultural productivity and strong ageing, development is mainly focused on tourism. In hilly areas poultry, because closely integrated with the regional processing industry, is significant (over 21% of regional total);
- *Mountain areas with high levels of socio-economic development and gaps in agricultural sector (cluster 7).* In this small part of the mountain area, the tourism contributes significantly to local development, while the primary sector is marginal;
- *Mountain areas with a low level of development (cluster 8),* given the absence of tourist activities and with high gaps in the agricultural sector (ageing).

C) Hilly systems with different levels of socio-economic development.

- *Systems with high socio-economic development and high specializations (cluster 1).* In this small portion of territory, in which lies a large share of the wine sector (over 12% of the total vineyard UAA) and fruit culture, the agricultural productivity is the highest in the region;
- *Plain and hilly systems with an average level of socio-economic development and highly specialized wine-growing (cluster 4).* In this large share of territory we find an high specialization on wine (41% of the vineyard UAA - wine-growing areas);

C) Plain systems with different levels of agricultural development.

- *Plains intensive and extensive areas (cluster 3).* At local level the agriculture

is important for employment (more than 6% of local employees) and for income (almost 5% of VA), while the weight of the food processing industry is almost irrelevant. The fruit culture is prevailing, with nearly a fifth of regional fruit surfaces and this implies a high agricultural productivity per hectare;

- *Extensive plain areas (cluster 10)*. This is a modest part of the Veneto plain, where agriculture is largely extensive, with over 15% of the regional arable UAA.

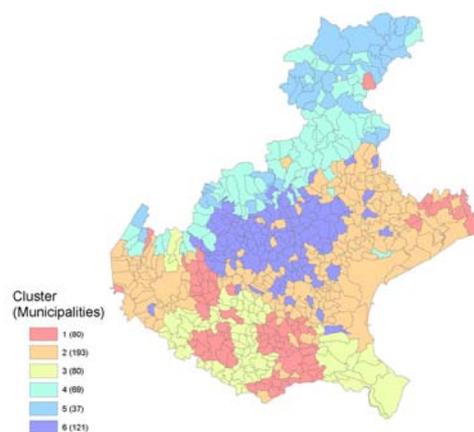
In this first phase, the attention has been paid to some PDO in dairy sector (Montasio and Asiago). First of all, we note that the presence of the Code of practices, if from a side increases the specialization, on the other increases only in part the agricultural profitability. The increase occurs only in highly specialized systems in the metropolitan area (cluster 2) and in the hilly systems with intensive agriculture (cluster 1). The PDO presence does not change substantially the issues of mountain areas with gaps in agricultural development (clusters 5, 7 and 8). In other words, the inclusion of these territories in the PDO geographical delimitation is not able to counter the local socio-economic dynamics; this could have important consequences in the future if adequate measures will be not designed both to support the most efficient firms and integrated development.

The territorial delimitation in each Code of practices, especially when it is very wide, is particularly significant. Montasio can be produced in the provinces of Treviso, Belluno and partly in Venezia; regarding the Asiago the territorial individualization is even larger: the provinces of Vicenza, Trento and a large proportion of municipalities of Padua and Treviso. Therefore the presence of these two PDO does not provide a real competitive advantage at local level

compared to the overall position of cluster membership. For example, the inclusion of a significant part of the province of Venice in the specification of Montasio contrasts with the fact that in the same province a very small number of dairies is associated with the Consortium, fact that shows that the production of Montasio interests a very small area.

The second part of the analysis makes it easier to single out the great dairy system of Veneto (Figure 2 and Table 6), which falls mainly in cluster 2 and 6; this system includes not only the province of Treviso, but extends mainly to the province of Vicenza, and in a lesser extent to Venice. Within this macro-system we can find almost 70% of dairy cows and the largely part of dairy PDO of the region. In fact, 75% of the municipalities of the Asiago falls in this macro-area, 60% of Grana Padano, 45% of the Monte Veronese, 50% of Provolone and 95% of the Taleggio. Especially in cluster 6, largely excluded from the regional definition, we clearly observe some agro-food district situations, especially for the Asiago,.

Figure 2 – Veneto: systems of agricultural specialization



In other words, the spatial analysis highlights how the detection of a single dairy district in

the province of Treviso is severely restricted because it does not allow either to defend the PDO in the international context, nor to address the ongoing problems at territorial level, nor finally to intervene effectively in situations where there are significant characters of quality agro-food systems. Besides, the administrative boundaries, which may provide a stability over time and space, cannot coincide with the boundaries of local systems, characterized by a necessary flexibility and variability, typical of social networks. Furthermore, if we consider the results of the first part of the analysis, which highlights how the potential agro-food districts are in the metropolitan area of Veneto, where the conflict is use of resources is considerable, and where the primary sector plays an irrelevant role in socio-economic development, the risk for local institutions is to ignore the many problems related to the agro-food sector, given their marginality compared to the territorial dynamics. Thus, the variety of institutional spaces complicates the achievement of efficient forms of local governance in agro-food system, understood as the effective ability to guide the use of local resources to achieve sustainable forms of development over time.

5. THE AGRO-FOOD DISTRICTS IN EMILIA ROMAGNA

In the first stage, namely that in which we used both socio-economic and agricultural variables, spatial analysis has identified the following main areas (Figure 3 and Table 7):

A) Systems with high level of socio-economic development and different levels of agricultural productivity.

- *Plane and part of mountain areas with high agricultural profitability (cluster 2).* A large part of this system presents an high industrialization, while the mountain areas are characterized by

development gaps with low population density and by an important role of the primary sector for employment and income.. The dominant activities are livestock (29% of regional bovines and 15% of pigs). The degree of integration with the processing industry is high, both meat, and dairy ;

Table 5 – Some indicators of main regional systems: Veneto (%)

<i>Cluster</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>
Municipalities	22	79	65	111	86	118	15	26	24	34
Per Capita Value Added (<i>Euro</i>)	27223.2	26004.3	22005.1	25166.9	24387.2	26173.0	26416.5	25220.0	28196.4	25592.2
Standard Gross Margin (SGM) per ha UAA (<i>Euro</i>)	5029.7	5832.1	3171.0	3779.3	2649.3	3468.7	956.1	940.8	2818.8	2761.3
UAA	3.0	17.3	12.8	15.5	10.3	24.4	0.6	1.7	3.5	11.0
UAA under Arable land	0.9	19.3	17.3	11.2	2.1	28.8	0.0	0.2	4.8	15.4
UAA under Cereals	10.9	42.0	60.4	33.0	8.7	45.7	0.0	0.0	66.1	58.4
UAA under Fruits	10.7	40.4	18.4	10.7	7.3	9.1	0.0	0.0	0.3	3.1
UAA under Vineyards	12.3	9.1	2.6	41.0	5.9	24.1	0.0	0.0	1.6	3.3
UAA under Pastures	4.0	9.5	0.6	20.0	42.0	11.8	3.0	8.4	0.2	0.3
Woodlands	3.3	3.7	0.5	12.5	36.9	2.9	6.9	32.6	0.1	0.5
Bovines	2.6	31.8	4.0	14.6	8.7	27.9	0.1	0.1	3.1	7.0
Dairy Cows	3.6	17.6	2.3	20.8	16.8	34.7	0.4	0.3	1.9	1.6
Pigs	2.8	28.9	7.4	7.7	12.0	30.8	0.0	0.0	0.8	9.5
Poultry	5.6	31.8	13.9	24.8	9.2	11.3	0.0	0.0	1.1	2.3
Agriculture Value Added	3.1	24.2	12.4	16.4	5.9	24.7	0.2	0.4	2.1	10.5
Total Value Added	3.6	19.2	5.2	17.4	7.3	32.7	0.4	1.0	5.0	8.1
Agriculture Employment on total Employment	4.2	25.9	12.3	17.7	5.7	23.0	0.2	0.4	2.0	8.5
Industry Employment on total Employment	2.6	18.6	5.5	21.9	8.3	30.7	0.6	1.0	3.7	7.1
Services Employment on total Employment	3.9	19.3	5.2	15.6	7.0	33.4	0.4	1.1	5.4	8.7
Food Industry: Employees/Local Units	4.0	32.7	5.2	18.1	5.7	24.8	0.1	0.9	2.4	6.1
Dairy Industry: Employees/Local Units	1.5	28.3	0.0	4.9	0.0	24.9	0.0	0.0	0.0	40.4
Municipalities with PDO “Asiago Cheese”	0.0	20.4	0.0	31.2	25.5	22.9	0.0	0.0	0.0	0.0
Municipalities with PDO “Montasio Cheese”	0.0	6.3	0.0	20.4	16.5	32.0	7.3	12.6	3.9	1.0
Municipalities with PDO “Grana Padano Cheese”	4.3	15.5	12.7	21.3	11.9	22.9	0.0	0.0	4.7	6.7
Municipalities with PDO “Monte Veronese Cheese”	41.2	7.8	0.0	31.4	19.6	0.0	0.0	0.0	0.0	0.0
Municipalities with PDO “Taleggio Cheese”	0.0	11.6	0.0	42.1	9.5	36.8	0.0	0.0	0.0	0.0

Table 6 – Some indicators of regional systems of agricultural specialization: Veneto (%)

<i>Cluster</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>
Municipalities	80	193	80	69	37	121
Per Capita Value Added (<i>Euro</i>)	22915.8	27153.5	19887.5	24919.8	25083.3	25357.8
Standard Gross Margin (SGM) per ha UAA (<i>Euro</i>)	3820.2	3967.5	3961.9	1861.6	916.6	4072.2
UAA	16.4	34.6	20.5	8.5	3.0	16.9
UAA under Arable land	18.9	35.9	27.1	1.6	0.0	16.5
UAA under Cereals	47.7	40.6	52.3	7.1	0.1	47.0
UAA under Fruits	28.0	47.0	18.0	1.8	0.0	5.1
UAA under Vineyards	23.0	60.7	5.9	1.0	0.0	9.4
UAA under Pastures	2.7	15.2	4.5	37.9	15.6	24.1
Woodlands	3.8	11.8	2.2	34.8	39.5	8.0
Bovines	7.8	26.4	20.4	6.7	0.4	38.3
Dairy Cows	3.4	32.7	10.0	13.0	1.1	39.8
Pigs	10.2	44.3	23.2	3.6	0.0	18.7
Poultry	24.4	43.1	22.5	1.8	0.0	8.1
Agriculture Value Added	17.2	39.2	23.2	3.4	0.6	16.4
Total Value Added	8.4	55.6	5.7	5.4	1.4	23.5
Agriculture Employment on total Employment	16.8	42.9	19.9	4.0	0.8	15.8
Industry Employment on total Employment	9.2	46.6	7.2	6.4	1.6	29.0
Services Employment on total Employment	8.2	58.6	5.4	4.9	1.5	21.4
Food Industry: Employees/Local Units	10.0	59.2	9.9	3.3	0.6	17.0
Dairy Industry: Employees/Local Units	0.4	56.7	40.4	0.1	0.0	2.4
Municipalities with PDO “Asiago Cheese”	0.6	18.5	7.6	12.7	5.1	55.4
Municipalities with PDO “Montasio Cheese”	3.9	45.6	1.0	21.4	13.1	15.0
Municipalities with PDO “Grana Padano Cheese”	15.5	37.4	15.7	5.9	2.0	23.7
Municipalities with PDO “Monte Veronese Cheese”	29.4	45.1	7.8	13.7	3.9	0.0
Municipalities with PDO “Taleggio Cheese”	1.1	63.2	0.0	4.2	0.0	31.6

Table 7 – Some indicators of main regional systems: Emilia Romagna (%)

Cluster	1	2	3	4	5	6	7	8
Municipalities	23	57	57	70	32	39	37	26
Per Capita Value Added (Euro)	24683.0	26712.0	22227.4	27479.2	30190.3	25342.1	23021.4	24854.6
Standard Gross Margin (SGM) per ha UAA (Euro)	4145.8	3918.7	3024.8	4317.0	2605.5	4085.3	3286.3	5021.5
UAA	5.6	14.2	10.7	21.3	8.3	13.6	21.4	4.8
UAA under Arable land	6.3	15.0	9.2	22.4	8.8	10.3	23.8	4.4
UAA under Cereals	34.4	27.4	11.0	37.4	41.3	25.3	42.9	29.0
UAA under Fruits	0.1	0.8	2.4	22.1	9.9	28.3	27.0	9.4
UAA under Vineyards	7.3	4.8	1.4	25.9	5.5	27.6	19.1	8.5
UAA under Pastures	3.3	24.4	33.9	10.8	5.6	19.8	0.7	1.4
Woodlands	3.7	23.0	35.9	4.2	5.0	15.8	1.8	10.6
Bovines	6.3	28.8	18.9	30.8	4.6	5.0	4.5	1.1
Pigs	1.4	15.1	10.7	49.3	3.0	12.4	4.9	3.3
Poultry	0.2	1.8	1.7	5.3	1.3	41.9	19.0	28.7
Agriculture Value Added	4.0	12.3	6.5	25.6	8.4	15.7	18.5	8.9
Total Value Added	4.3	10.7	4.7	31.0	19.2	11.0	9.9	9.2
Agriculture Employment on total Employment	5.1	12.5	7.1	25.0	9.0	15.8	17.4	8.3
Industry Employment on total Employment	3.5	10.9	5.7	36.4	16.0	11.0	9.1	7.4
Services Employment on total Employment	4.7	10.2	4.6	26.9	21.1	11.6	10.2	10.7
Food Industry: Employees/Local Units (ELU)	3.2	14.9	13.1	28.1	9.2	9.8	11.0	10.7
Meat Industry A15111: ELU	1.2	8.1	17.6	60.4	2.6	4.8	3.5	1.7
Meat Industry A15112: ELU	0.0	0.0	58.9	13.3	0.0	4.4	17.8	5.6
Meat Industry A15130: ELU	3.7	9.7	43.6	30.8	8.6	1.3	1.9	0.4
Dairy Industry: ELU	3.2	23.8	27.6	28.7	9.2	1.9	2.1	3.3
Municipalities with PDO "Parmigiano Reggiano cheese"	0.0	21.5	32.2	38.3	8.1	0.0	0.0	0.0
Municipalities with PDO "Grana Padano cheese"	18.9	20.5	0.0	1.6	4.1	23.8	25.4	5.7
Municipalities with PDO "Parma Ham"	0.0	42.4	57.6	0.0	0.0	0.0	0.0	0.0
Municipalities with PDO "Modena Ham"	0.0	2.9	35.3	29.4	32.4	0.0	0.0	0.0
Municipalities "Agro-food District Parma Ham"	0.0	5.6	94.4	0.0	0.0	0.0	0.0	0.0

Table 8 – Some indicators of regional systems of agricultural specialization: Emilia Romagna (%)

Cluster	1	2	3	4	5	6	7
Municipalities	111	23	42	90	11	53	11
Per Capita Value Added (<i>Euro</i>)	26944.7	10443.4	17973.7	25896.6	13504.9	38240.1	45200.7
Standard Gross Margin (SGM) per ha UAA (<i>Euro</i>)	4241.1	3255.3	2350.6	3436.5	5189.6	4330.6	6662.9
UAA	27.9	12.0	7.1	36.7	2.5	12.9	0.9
UAA under Arable land	28.7	13.7	5.6	38.4	2.2	10.5	0.9
UAA under Cereals	27.0	43.1	13.2	38.7	20.9	29.2	34.2
UAA under Fruits	9.5	9.7	1.6	47.2	1.5	28.9	1.5
UAA under Vineyards	24.9	1.4	2.1	34.2	4.9	31.5	1.0
UAA under Pastures	38.6	6.2	25.7	16.6	4.9	7.7	0.3
Woodlands	25.8	4.7	33.1	16.0	1.6	13.7	5.2
Bovines	59.7	3.4	8.1	18.2	7.0	3.5	0.1
Pigs	61.0	2.1	1.9	20.8	7.7	6.3	0.2
Poultry	7.5	19.0	0.5	20.7	1.8	44.2	6.2
Agriculture Value Added	28.4	11.0	3.4	28.7	4.5	20.1	3.9
Total Value Added	31.4	2.5	1.5	28.3	5.9	26.7	3.5
Agriculture Employment on total Employment	28.2	8.4	3.8	30.5	4.7	20.8	3.6
Industry Employment on total Employment	37.2	3.0	1.8	24.9	6.5	23.5	3.1
Services Employment on total Employment	28.0	2.4	1.6	29.5	5.3	29.1	4.1
Food Industry: Employees/Local Units (ELU)	38.1	3.4	1.8	22.6	10.7	20.8	2.6
Meat Industry A15111: ELU	40.1	0.4	1.5	12.0	39.9	5.4	0.7
Meat Industry A15112: ELU	23.3	17.8	5.6	0.0	43.3	10.0	0.0
Meat Industry A15130: ELU	54.4	0.4	3.2	7.8	29.7	4.4	0.1
Dairy Industry: ELU	63.3	1.3	4.9	10.9	10.3	8.9	0.5
Municipalities with PDO “Parmigiano Reggiano cheese”	61.7	0.7	17.4	8.7	3.4	8.1	0.0
Municipalities with PDO “Grana Padano cheese”	9.8	17.2	12.3	37.7	2.5	16.4	4.1
Municipalities with PDO “Parma Ham”	54.5	0.0	36.4	0.0	3.0	6.1	0.0
Municipalities with PDO “Modena Ham”	55.9	0.0	11.8	8.8	8.8	14.7	0.0
Municipalities “Agro-food District Parma Ham”	61.1	0.0	27.8	0.0	5.6	5.6	0.0

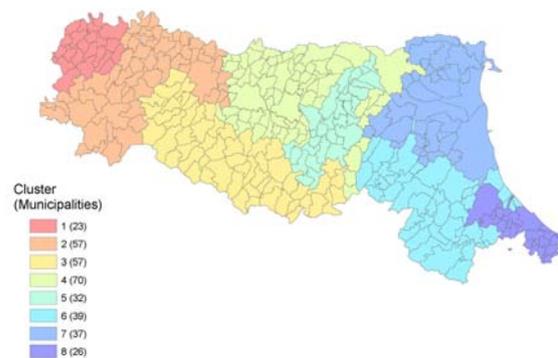
- *Highly industrialized areas with intensive agriculture (cluster 4).* In these territories, with an index of aging of the population below the regional average, we find some industrial districts, with urban settlements of medium and small size. Regarding agro-food profile, we are facing at the heart of regional system. The activities regard cereals (22% of the regional cereal UAA), fruit (22%), wine (26%) and livestock (31% of the regional bovines, 49% of the pigs). The integration with the food industry is strong with 28% of total employees;
- *Peri-urban areas with the highest level of development and with intensive and extensive agriculture (cluster 5).* In this cluster we find the largely part of the municipalities in the province of Bologna. The data highlight their leading role in regional development, with nearly 20% of the regional VA; despite of the development of the area it is mainly focused on the tertiary sector with the irrelevance of the primary sector at local level, the agro-food system contributes to regional productivity, with more than 8% of the VAA and 9% of employees in the processing industry. The prevailing cultures are cereals (almost 11% of regional total) and fruits (9%).

B) Systems with a medium level of development and high agricultural productivity.

- *Mountain and plane areas (cluster 1).* The prevailing cultures are horticulture and livestock;
- *Plain areas with intensive agricultural systems (cluster 6).* In this large share of the regional territory with a level of development slightly below the regional average, the s economy, also if predominantly tertiary, stands out with

its agricultural character, with almost 16% both of VAA and of regional agricultural employees. The cultures are vineyards (almost 28% of total vineyard UAA) and fruits (28%). Widely spread is also the poultry farming (nearly 42% of the total);

Figure 3 – Emilia Romagna: main regional systems



- *Tourist areas with intensive agriculture (cluster 8),* with 29% of poultry.
- C) Systems with differences in socio-economic and agricultural development.*
- *Plain intensive and extensive areas with low level of development (cluster 7).* The rate of agricultural employment at local level is the highest in the regional setting. The prevailing activities are cereals ((28% of regional cereals UAA), fruit (27%) and wine (19%);
 - *Mountain areas with low socio-economic and agricultural development (Cluster 3).* In this cluster (36% of regional woods), we find a strong gap in socio-economic development and a low population density (5%). The livestock systems are prevalent (nearly 19% of the regional bovines and 11% of pigs). At the local level the food industry plays an important role (more than 30% of the total employees) both dairy sector and meat processing.

The whole territory of Emilia Romagna is invested by the presence of disciplinary for PDO and PGI products. This is not only due to the large presence of DOC wine-growing areas, but especially to the definition contained in the Code of practices of the two main products of the region (Parmigiano Reggiano and Grana Padano)⁵. In contrast to what occurs for Parmigiano Reggiano, for which the Code requires only the use of milk from that area, for Parma and Modena Hams, the need to respond to an increasing consumption resulted in a significant expansion of the rearing phase in most of northern and central regions, while the further steps with higher value added remain in the local system. This presence of other typical products means that a large part of the territory is home of many quality products, in particular about 30% of the municipalities are home of three typical products, 5% more than 4, while only 18% of them belong to a single specification. In a first approximation, the wide spread of typicality may be insignificant, but the study shows that the importance of cluster 3 is directly related to the presence of municipalities with more PDO.

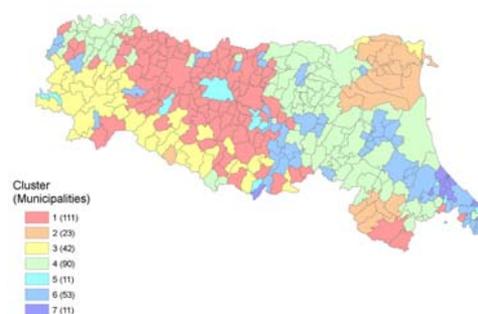


Figure 4 – Emilia Romagna: systems of agricultural specialization

If the analysis moves on individual products, further consideration may be conducted. As in Veneto, the presence of the Code of practices, if increases the specialization, on the other increases only in part the agricultural profitability in the included territories in comparison with the regional and cluster average, except in the cases with more or less accentuated gaps in development. In other words, the difference in profitability depends in substantial measure on the weight of the latter in the geographical extent of individual products: this is true in part for the Parmesan, and in case of Parma Ham the presence of the subsequent stages of the supply chain in disadvantaged areas is not sufficient to ensure the enhancement of local production. The second part of the analysis allows to better assess whether the regional strategies of not detecting *a priori* the agrofood quality systems, but to support the initiatives that are formed at the local level, is the most opportune. The next zoning has been carried out, as already mentioned, only on agricultural variables (Figure 4 and Table 8); attention has been paid to the system of Parmigiano Reggiano and of Parma and Modena Hams. The results show a large regional system (cluster 1), which occupies more than 28% of the regional surface region, which account for 60% of both cattle and pigs. The high agricultural profitability is directly related to the number of

⁵ The specification of Parmigiano Reggiano provides that the milk, produced according to certain technical standards, can come from all the municipalities of Parma, Reggio Emilia, Modena and from part of the province of Bologna, while the second turns to the rest of the region.

municipalities that belong to Parmigiano Reggiano (61%) and to Parma (54%) and Modena Hams (55%). The tight integration with the food industry is evidenced by the strong concentration of the processing industry with over 38% of regional employees. If we consider the results of the previous zoning, it can be observed that the potential agro-food districts are mainly located in areas with the highest level of socio-economic development and higher density of both public and private institutions, but also in some with development gaps. In this macro-system individual agro-food districts overlap and it is therefore difficult to identify their boundaries. Furthermore, the complexity of the processes of differentiation, not only in agriculture, involves a variety of institutional spaces, with different forms of concerted action and partnership among institutions, and economic actors. This can cause difficulties in achieving efficient forms of local governance, understood as the effective ability to guide the use of all local resources in order to achieve sustainable forms of rural development. These considerations regard particularly the territories included in cluster 3, as they fall within a large number of municipalities included in the specification of Parmigiano Reggiano (17%) and of Parma Ham (36%). In these territories, which belong to mountain systems with large gaps in the development and with strong ageing index, with a likely absence of a generational change, they could lead to repercussions on the productive potential of PDO, particularly the one of Parmesan cheese.

6. CONCLUSIONS

The main objective of this study was to assess whether existing instruments to promote and support local products in the new international scenario are adequate and which of them will be able to achieve these

goals. This was done through the investigation of the approaches followed in two regional contexts, which adopted different paths.

The answers are many:

a) in both regions the production systems related to PDO are highly complex and have within them a variety of different socio-economic, environmental and cultural situations. If Arfini, Marescotti and Belletti (2010) argue that for such products the composition of interest gives rise to a dominant strategy driven by the needs of the most influential actors, the survey highlights how the composition is dominated not only by the actors, but also on their localization, at the expense of territories with less institutional presence and development gaps. This occurs in both regions, both in the case of Parma Ham and Parmigiano Reggiano, both for dairy PDO (Asiago, Montasio) in Veneto. This leads to state that the policies for designations of origin must have as its purpose to put the conditions in different production systems to develop their productive potential and environmental performance through a set of diversified tools.

b) as regards the identification of quality agro-food districts, opportunity offered by the Italian legislation and poorly still present in the Italian reality, their individualization at regional level can present many difficulties. On the one hand this definition is conditioned by the overall approach from the regional institutions for local development, not only in the agro-food system; it emerges clearly from the path followed in the two regions investigated. Second, even the agro-food districts, where identifiable, are conditioned by the socio-economic dynamics in their territories, in addition to the strategies adopted by the Consortium for typical products, which are, as already said, the results of the needs of actors and the

areas most influential. In the case of Emilia Romagna, the Agro-food District of Parma Ham, from the bottom up, investing only a portion of the area affected by the regulations.

c) The survey highlights the regional dimension in agro-food systems, including different models of local development and operating in relation to other regions as well as to the national and global system. The aim of the regional institutions should be to enhance regional food production, through the maximum flexibility and a significant social and economic returns to all stakeholders. For this purpose, the regional institutions should provide the tools for understanding the spatial dynamics existing in the territory to all public and private actors, their interrelationships, the points of the strength and weaknesses, not favoring one tool over another. For example, in the Veneto region the analysis show a large production system, which contains the suited areas of dairy PDO and is beyond the provincial borders. The task of the regional institutions would mainly take measures to foster cooperation and partnership at local level, but also the most appropriate strategies for rural development in all contexts.

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Appendix

We create for every region a matrix VR with the variables described in paragraph 3 (see Table 4). The matrix VR was analysed by multispati-pca (Dray *et al.*, 2008), which is a generalization of Multivariate Spatial Correlation Analysis (Wartenberg 1985). This method allowed taking into account the spatial position of sampling sites through a neighbouring relationship between sites (in our cases a contiguity queen matrix of first order). As explained in Dray *et al.* (2008), the multispati analysis introduces a spatial weighting matrix \mathbf{W} in the Principal Component Analysis (PCA) of the data matrix \mathbf{X} . Here \mathbf{X} is the matrix VR: it has n rows (municipalities) and p columns (variables). \mathbf{W} is the row-sum standardized connectivity matrix (contiguity matrix of first order): if $\mathbf{C} = [c_{ij}]$ is the connectivity matrix (indicating the strength of interactions between units i and j), then $\mathbf{W} = [c_{ij} / \sum_{j=1}^n c_{ij}]$. Let \mathbf{D} be a scalar product of R^n , and let \mathbf{Q} be a scalar product of R^p . $(\mathbf{X}, \mathbf{Q}, \mathbf{D})$ is the statistical triplet associated to the PCA of \mathbf{X} , and the multispati analysis is the co-inertia analysis (Dray *et al.*, 2003) between \mathbf{X} and the lag matrix $\tilde{\mathbf{X}} = \mathbf{W}\mathbf{X}$. The lag matrix $\tilde{\mathbf{X}}$ is composed of the averages of neighbouring values weighted by the spatial connection matrix (this means that only the neighbouring points are taken into account). Multispati maximizes the scalar product between a linear combination of the original variables ($\mathbf{a}_1 = \mathbf{X}\mathbf{Q}\mathbf{u}_1$) and a linear combination of the lagged variables ($\tilde{\mathbf{a}}_1 = \mathbf{W}\mathbf{X}\mathbf{Q}\mathbf{u}_1$). ($\mathbf{a}_1 = \mathbf{X}\mathbf{Q}\mathbf{u}_1$) and a linear combination of the lagged variables ($\tilde{\mathbf{a}}_1 = \mathbf{W}\mathbf{X}\mathbf{Q}\mathbf{u}_1$). In practice, it is necessary to diagonalize the \mathbf{Q} -symmetric matrix

$\mathbf{H} = (1/2)(\mathbf{X}^t(\mathbf{W}^t\mathbf{D} + \mathbf{D}\mathbf{W})\mathbf{X}\mathbf{Q})$ instead of matrix $\mathbf{X}^t\mathbf{D}\mathbf{W}\mathbf{X}\mathbf{Q}$, which is not symmetric. The advantage of multispati over PCA is that multispati sample scores maximize spatial autocorrelation between sites, while conventional PCA scores maximize the inertia (i.e., the sum of variances).

Multispati scores are therefore “smooth” and show strong spatial structures on the first few axes, while PCA scores can be rough, smooth, or mixed and can show spatial structures on any axis (even distant ones). Moreover, the advantage of multispati over Wartenberg's classical Multivariate Spatial Correlation Analysis (Wartenberg, 1985) is that multispati is not restricted to the case of quantitative normalized variables, but can be applied to any type of variable and any type of analysis (for example, binary variables, counts, or qualitative variables and principal component analysis, correspondence analysis, or multiple correspondence analysis).

The aim of multispati is to produce site scores that maximize spatial autocorrelation. This property ensures that the geographical maps of these scores are smooth and easy to interpret. The multispati analysis has been implemented in the *ade4* package for the R software (Chessel *et al.* 2004).

Finally, a Monte-Carlo test was used to check the statistical significance of the observed structures. This test is a multivariate permutation test against a random distribution of the values of the VR over the sampling sites. It does not rely on statistical distribution hypotheses. Computations were conducted with the “*ade4*” and “*spdep*” packages (Bivand *et al.*, 2010) for the R statistical software (R Development Core Team, 2010).