An Exploratory Spatial Data Analysis for Detecting the Indicators for Assessing the Decoupling Schemes

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Contribution appeared in Arfini, F. (Ed.) (2005) "Modelling Agricultural Policies: State of the Art and New Challenges", proceedings of the 89th EAAE Seminar, pp. 791 - 809

February 2-5, 2005

Parma, Italy

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Abstract

This paper verify as the different socio-economics indicators divide in cluster the European regions to furnish the helpful information to understand that will be the impact of the changes of the Common Agricultural Policy, using a methodology of exploratory spatial analysis (ESDA). In this case is used the geographically weighted regression (GWR), technique aimed at describing and visualizing spatial distribution and at detecting patterns of spatial association. The principal results that refer to some economic variables of the agricultures of the European regions are introduced.

Keywords: Decoupling, ESDA, GWR, Regional Model.

1. Introduction

The purpose of the work is to verify how the different socio-economics indicators divide the European regions in clusters, to furnish helpful tools to policy makers at different level to understand the impact of the changes of the Common Agricultural Policy.

Nowadays this analysis results particularly important. The Fischler reform, definitely approved in the month of September 2003, marks a line of discontinuity in the complicated process of redefinition of the agricultural politics of the European union. The pillars of the reform are: the decoupling, the modulation and the cross-compliance. The decoupling, that represents the true innovation of the Reform, involves the move of the support from the product to the producer. This measure will allow smaller distortions of markets, since the farmers can find their conveniences in the market and manage their enterprises efficiently. The modulation, with a cut of 5% to regime of the subsides of the PAC, will increase the financial endowment of rural policies, particularly in the disadvantaged regions. Finally the cross-compliance, become obligatory, and the single payment, will be contemplated to the production of good and

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services of collective interest, not only for the safeguard of the environment, but also for the safety of the foods and the comfort of the animals.

Public policies, like agricultural policies, are one of the main driving forces of structural change in agriculture. Within Europe, it has been recognised that the coupled direct payment system has impeded the efficient allocation of resources and it has allowed inefficient land-use and farmers have remained in production for longer than would have otherwise been the case in the absence of such payments.

The impacts of the Fischler reform on markets, farm income, rental value of land and prices of other fixed factors have not yet been analyzed adequately. Studies for the request of the EU Commission were realised at a rather aggregated level and the results are neither broken down to member states level. Other issues related to decoupling are not analysed in detail, particularly the "re-localisation" of productions and the impacts on rural income and environment at regional level.

For this reason the object of this study will be an analysis of the impact in some European regions of the measures foreseen from the McSharry reform and from Agenda 2000. The considered period is that inclusive between 1993 and 2003. The reason is the necessity to understand if and how an incisive Reform like the McSharry has changed the geography of the products and the European agricultural producers, as well as the scenery where the new CAP reform is placed. Objective of the investigation would have been the whole European regional universe but substantial lacks in REGIO data bank, on which will return in the following paragraphs, have prevented the attainment of this result.

The expected results of our study are the detection of different territorial systems in EU in relation to decoupling schemes and the classification of the territorial units in each level (i.e. NUTS 2 or NUTS 3), in relation to socio-economics dynamics.

Choosing the indicators for assessing the decoupling schemes at territorial level is a complex operation (Montresor, 2002). Their number should not be too large and the risk would be their difficult interpretation, due to the small relevance of some agricultural and rural development parameters, essential for defining homogeneous territorial systems, in relation to the socio-economic dynamic and environmental dimension. The grid of indicators should be able for reading the decoupling schemes and for monitoring the adopted measures efficiency.

For the detection of the indicators we will use the recently developed methods of Exploratory Spatial Data Analysis (ESDA). By identifying global and spatial correlation, we can characterize the different values of the socio-economic indicators located in EU and how this pattern of location has changed over time. Moreover, local spatial statistics can provide an insight into spatial heterogeneity within the sample and its persistence over time. ESDA is a set of techniques aimed at describing and visualizing spatial distribution, at identifying atypical localizations or spatial outliers, at detecting patterns of spatial association, clusters or hot spots, and at suggesting spatial regimes or other forms of spatial heterogeneity (Anselin, 1988, 1996, 1999).

More specifically, spatial autocorrelation can be defined as the coincidence of value similarity with location similarity. Spatial heterogeneity means that economic behaviour is not stable over space and may generate characteristic spatial pattern of economic development under the form of spatial regimes; i.e. a cluster of rich regions being distinguished from a cluster of poor regions. The measurement of global spatial autocorrelation is based on Moran's I statistics, which is the most widely known measure of spatial clustering, but does not allow to assess the regional structure of spatial correlation. However, it may be asked whether there are local spatial cluster of high or low values, which regions contribute more to the global spatial correlation, and finally to what extent the global evaluation of spatial autocorrelation masks atypical localizations or "pocket of local nonstationarity", i.e. respectively regions or groups of neighbouring regions, which deviate from the global pattern of spatial correlation.

2. The proposed methodology

Exploratory Spatial Data Analysis (ESDA) techniques, including global spatial process analysis, local pattern of spatial effects and detection and test of local nonstationarity under significant global spatial process, spatial regression and geographically weighted regression (GWR) supply the main analytical techniques in understanding the principal modifications in the past decade of the distribution of the subsidies, due to the CAP in some European Regions. Other applications of these methodologies for the study of the transformations induced from the CAP in the agricultures of the European regions are in Pecci (2000), Fanfani and Pecci (2001) and Bivand and Brunstad (2003).

The models we will introduce represent the attempts to accommodate spatial variation in modeling spatial process and analyzing regional transformation. The essence of local models is that they allow the parameters of the model to vary with the geographical location of the sample data (vs. in the global model, parameters of the model are all-the-same across various geographical locations).

The first such model was introduced by Casetti (1972) and later modified, and generally labeled a spatial expansion model. In a very general way, the model is shown as follow:

$$Y = X\boldsymbol{\beta} + \boldsymbol{\varepsilon}$$

$$\boldsymbol{\beta} = Z\boldsymbol{\beta}_0$$

where:

$$\boldsymbol{Z} = \begin{pmatrix} 1 & Z_{E1} & Z_{N1} \\ \vdots & \vdots & \vdots \\ 1 & Z_{En} & Z_{Nn} \end{pmatrix} \text{ and } \beta_0 = \begin{pmatrix} \beta_E \\ \beta_N \end{pmatrix} \tag{1}$$

The geographical location information is recorded in the matrix **Z**, the elements Z_{Ei}, Z_{Ni}, $i = 1, \dots, n$ (the number of observations) represent latitude and longitude coordinates (East direction and North direction) of each observation. The original parameter matrix $\boldsymbol{\beta}$ (k*1, k is the number of explanatory variables) was expanded by the geographical location information. Such model specification actually posits that the parameters of the model vary as a function of geographical location (represented by latitude and longitude coordinates, which are already known). The expansion method has been very important in promoting awareness of spatial nonstationarity and geographical variation. However, it does have some limitations. Geographically weighted regression, as a form of locally weighted linear regression method introduced in McMillen (1996, 1997).

Considering the spatial expansion models (1), if we replace the $\boldsymbol{\beta}$ term in the first equation with the second equation, and we assume a much more general parsimonious specification of the expansion equation than the linear one above (say, for example, let $\boldsymbol{\beta} = f(Z_E, Z_N)$, f is a (k + 1) * 1 dimension function vector, representing the actual spatial variation of the regression coefficients at each location, $\boldsymbol{Z_E}$, $\boldsymbol{Z_N}$ represent the vector of geographical coordinates on east and north directions), we obtain:

$$Y = Xf(Z_E, Z_N) + \boldsymbol{\varepsilon} \tag{2}$$

This model is termed the geographically weighted regression by Fortheringham, Brunsdon and Charlton (1996, 1998, 1999, 2002). Instead of assuming a specific function form of the spatial expansion equation, GWR model only assume that there is a continuous surface of parameter values, which takes the form as $f(\boldsymbol{Z_E}, \boldsymbol{Z_N})$. At this point, it is worth mentioning that since the expansion equation $f(\boldsymbol{Z_E}, \boldsymbol{Z_N})$ is parsimonious in nature, an unbiased estimate of the local coefficient is not possible (bias here results from inferring the outcome of a non-stationary process at location *i* from data collected at locations other than *i*). In GWR, an observation is weighted in accordance with its proximity to location *i* so that the weighting of an observation is no longer constant in the calibration but varies with *i*. Data from observations close to *i* are weighted more than data from observations farther away.

To obtain the geographically varying estimates, let's rewrite the ordinary regression equation (OLS) and its estimation:

$$Y = X\boldsymbol{\beta} + \boldsymbol{\varepsilon}$$

by ordinary least square technique, the familiar estimation form of $\boldsymbol{\beta}$ is:

$$\hat{\beta} = (\mathbf{X'X})^{-1}\mathbf{X'Y}$$

Recall from the above GWR mode (2), with slight change in the matrix form, the equivalent of the ordinary regression model is:

$$\mathbf{Y} = (\beta^* \otimes \mathbf{X})\mathbf{1} + \varepsilon$$

where $\otimes$ is a logical multiplication operator in which each element of $\boldsymbol{\beta}^*$ is multiplied by the corresponding element of X. For n observations and k explanatory variables, both $\boldsymbol{\beta}^*$ and X are n * (k+1) matrix and $\mathit{1}$ is a (k +1) * 1 vector of 1s (Fortheringham, et al. 2002). The elements of the matrix $\boldsymbol{\beta}^*$ is determined by the elements of the function vector f, and take the form of:

$$\beta^* = \begin{pmatrix} f_0(Z_{E1},Z_{N1}) & f_1(Z_{E1},Z_{N1}) & \cdots & f_k(Z_{E1},Z_{N1}) \\ f_0(Z_{E2},Z_{N2}) & f_1(Z_{E2},Z_{N2}) & \cdots & f_k(Z_{E2},Z_{N2}) \\ \cdots & \cdots & \cdots & \cdots \\ f_0(Z_{En},Z_{Nn}) & f_1(Z_{En},Z_{Nn}) & \cdots & f_k(Z_{En},Z_{Nn}) \end{pmatrix}$$

f_j (Z_{Ei}, Z_{Ni}) is a function value for coefficient j (j = 0,…, k, the first coefficient is the intercept, and subscripted as 0 by default) at location i (i = 1,…,n), and will be simplified as $f_j(i)$ in individual value and $f(i)$ in matrix notion. According to the weighted least square technique, the estimation of $f(i)$ is:

$$\hat{\boldsymbol{f}}(i) = (\boldsymbol{X}'\boldsymbol{W}(i)\boldsymbol{X})^{-1}\boldsymbol{X}'\boldsymbol{W}(i)\boldsymbol{Y}$$

where $\boldsymbol{W}(i)$ is an $n * n$ diagonal spatial weighting matrix that except for the diagonal elements of the matrix representing the weighting mechanism of the observation i and other observations in the dataset, other elements are zeros, in matrix form:

$$\boldsymbol{W}(i) = \begin{pmatrix} w_{i1} & 0 & \cdots & 0 \\ 0 & w_{i2} & \ddots & 0 \\ \vdots & \ddots & \ddots & \vdots \\ 0 & 0 & \cdots & w_{in} \end{pmatrix}$$

From the above discussion, we see that different weighting scheme will result different parameter estimations, thus the selection of weighting scheme becomes important in calibrating GWR models. Rather different from using contiguity rule (border-sharing) in the univariate spatial analysis when we are only interested in the spatial dependence/association of spatial units, contiguity rules would not provide much insight in GWR analysis since such rule practically result in local regressions with only a handful of sample data and a constant weight for the neighbors. Distance rules are more appropriately employed under such circumstances. One obvious and often cited choice is the Gaussian distance-decaying function, where:

$$w_{ij} = \exp[-\frac{1}{2}(d_{ij}/b)^2] \quad (j = 1, \ldots, n) \text{ for all } i = 1, \ldots, n \tag{3}$$

where b is usually referred to as the bandwidth. The Gaussian distance-decaying weighting scheme gives every observation in the dataset a weight larger than zero. The idea may be genuine since it is always possible that “everything is related with everything else”. However, some of the observations that are far enough away from the observation i and their weights may be very near zero, the inclusion of such observations in calibrating the GWR model may increase the computational intensity, but alters the parameter estimation very little. For this consideration, an alternative weighting scheme utilizes the bi-square function to produce the weights (Brunsdon et al. 1996, 1997; Fortheringham et al. 1998, 2002):

$$w_{ij} = \begin{cases} [1-(d_{ij}/b)^2]^2 & \text{if } d_{ij} < b \\ 0 & \text{otherwise} \end{cases} \quad (j = 1, \ldots, n) \text{ for all } i = 1, \ldots, n \tag{4}$$

This weighting scheme is particularly useful because it provides a continuous, near-Gaussian weighting function up to distance *b* from the observation *i* and then zero weights any observations beyond *b*.

Methods of selecting optimal bandwidth are abundant in the literature. One obvious way would be to minimize the quantity:

$$cv = \sum_{i=1}^{n} (y_i - \hat{y}_{\neq i}(b))^2 \tag{5}$$

where y_i is the observed dependent variable value of the *i*th observation, and $\hat{y}_{\neq i}(b)$ is the GWR fitted value of y_i using a bandwidth of *b* with the observations for point *i* omitted from the calibration process. The minimization of such problem is called the out-of-sample cross-validation (CV) approach suggested for local regression by Cleveland (1979) and for kernel density estimation by Bowman (1984). The reason of omitting observation *i* in the procedure of calibration is because the inclusion of observation *i* will actually result a zero bandwidth which gives the actual y_i as the estimates, and produce a useless zero *CV* score. With this procedure, and after the selection of a weighting scheme (the weighting scheme has to be decided before the cross-validation procedure, since the cross-validation will use the weighting scheme to produce fitted value of observations), the one *b* results in smallest *CV* score is the optimal bandwidth. Other approaches of determining the optimal bandwidth by minimizing the Akaike Information Criterion (AIC), or Bayesian Information Criterion (BIC, also referred to as the Schwartz Information Criterion, SIC) are present in the literature (Fotheringham, et al. 2002). Methods of producing spatially varying bandwidths also can be found in the literature, for detailed discussion, see Fortheringham, et al. (2002).

3. The main results

The European regions analysed in the study are 56, Denmark, Germany (NUTS 1), Holland (NUTS 1), Luxemburg, France (NUTS 2), Austria (NUTS 1), Great Britain (NUTS 1) and Ireland (NUTS 1).

These regions represent the heart of the continental agriculture, where in the past years must of CAP subsidies were concentrated.

The source of the data is the REGIO data bank recently available also trough Internet from the EUROSTAT. Since the data bank actually doesn't allow having complete information for the agriculture of all the European regions (EU 15), the EU regions analysed in the study are those for which the information are more complete.

In this studies we use some agricultural indicators (economic and structural variables of the agricultures of the European regions) to verify:

- the transformations of the relationship between subsidies and agricultural production following the CAP reform of 1992 that actually defines the amount of the decoupled subsidies;
- the link between subsidies and territories, if it is casual or referable to the geographical position;
- the indicators that better interpret the changes in the regional agricultures and the dynamics of the subsidies.

The situations that are confronted are those relative to the average value of the variables in the years 1993-1995 (first period) and 2000-2002 (second period).

For the analysis we use the GWR methodology, described in the preceding paragraph and the construction of the models has been sort following some criterions:

- the homogeneity of the independent variables in the different models (economic values of the productions, land-use, OTE, etc);
- since the purpose of the analysis is to furnish meaningful answers at regional level , the choice of the variables for the different models has been done comparing the values of the spatial correlation to general level but to regional level in the residuals of the OLS regression. We have preferred as possible the situations that pointed out meaningful values of spatial correlation; in such way trough the GWR we are able underline the variables non-stationary and then the similarities and the dissimilarities between the regions. In other words we have preferred to define some models, that through coherent variables with the purposes of the analysis, can show the presence of nonstationarity (cluster) at territorial level.

In the studied regions, in the analysed period, the value and the interquartile variability of the total subsidies per hectare of UAA increases (tab. 1), while the GVA per hectare remains substantially constant. For the GVA at the territorial level (fig. 1 and 2) this situation is confirmed; its value tend to increase in superior measure in the richest regions, while remains substantially unchanged in the regions with the lowest values Therefore substantial moves don't happen between the regions. In 1993-95 the 20% of the less rich regions had a GVA/UAA under the 653 Euros and the 20% of the richest it was above 1287 Euros of GVA/UAA. In 2000-2002 the poor ones are under the 686 Euros of GVA/UAA and the rich ones are above 1447 Euros.

Tab. 1. Summary of GVA, total subsidies and cereals subsidies per ha/UAA

Variable	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
GVA (93-95)	307.7	700.8	919.8	1240.0	1263	7974
GVA (00-02)	282.5	736.6	1011	1243.0	1287	7462
Subsidies (93-95)	8.789	145.5	179.6	175.2	205.9	421.1
Subsidies (00-02)	17.91	178.7	239.6	216.0	267.2	305.8
Subs/GVA (93-95) (%)	1.491	13.49	18.72	19.71	28.03	40.94
Subs/GVA (00-02) (%)	1.267	16.64	24.66	23.96	32.45	58.08
Cer. Sub./Subs. (93-95) (%)	5.053	34.04	47.7	43.11	55.61	77.45
Cer. Sub./Subs. (00-02) (%)	4.005	33.79	50.33	48.91	66.29	84.62

Font: HTTP://EPP.EUROSTAT.CEC.EU.INT.

If we compare the incidence of the total value of subsidies for hectare, tied to the CAP, on the GVA, the situation is enough different first and after the McSharry reform (fig. 3 and 4). Firstly it increases the incidence of the subsidies, in the first period the 20% of the regions with the lowest incidence of subsidies are set to the under of the 10%, in the second the least incidence raises to the 15%. But it is that the 20% of the regions have an incidence of the subsidies over a third of the GVA. It changes in evident way the geographical position of the regions with the greatest incidence of subsidies; in the first period were mostly favourite the German and Austrian regions, subsequently it is the France to profit of the changes consequent of the CAP reform of the 1992.

For better understanding how these changes at the territorial level can be connected to the different productions we have considered some GWR models in which the dependent variable is the value per hectare of the total subsidies and the independent variables are constituted from the values of the productions for hectare.

Tab. 2. Summary of GWR coefficient estimates: values of productions[1] (1993-95)

Variable	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.	Signif.[2].
intercept	35.620	69.560	89.380	99.300	122.800	209.800	.
cereals	0.039	0.193	0.244	0.255	0.306	0.574	***
crops	-0.074	-0.028	-0.003	-0.016	0.000	0.007	***
animals	-1.332	0.000	0.058	0.021	0.134	0.415	***
cattle	-0.315	-0.110	0.001	0.087	0.059	2.068	***
pigs	-0.453	-0.165	-0.091	-0.016	0.024	1.530	***
milk	-0.533	-0.087	-0.035	-0.074	-0.008	0.072	***

[1] Weighting function: bisqaure, bandwidth adaptive about 25 nearest neighbour.

[2] Leung *et al.* F3 (2000a). Signif. codes: *** 0.001, ** 0.01, * 0.05, . 0.1.

The results of the estimates are reported in the tables 2 and 3. The two models differ in part in the independent variables; while for the vegetable productions the same variables are present in the two analysed period, the variables referring to the livestock are differentiated. In particular in the first model it is present the variable that expresses the aggregate value of the animals, in the second this variable is replaced from the value of the animal productions.

Tab. 3. Summary of GWR coefficient estimates: values of productions[1] (2000-92)

Variable	Min	1st Qu.	Median	Mean	3rd Qu.	Max	Signif.[2]
intercept	4.063	37.450	99.390	84.590	123.700	163.600	**
cereals	0.221	0.281	0.350	0.376	0.467	0.725	***
crops	-0.151	-0.029	-0.014	-0.025	-0.002	0.002	***
cattle	-0.049	0.143	0.191	0.199	0.214	0.464	*
pigs	-0.205	-0.082	-0.005	0.013	0.083	0.490	*
anim. prod.	-1.259	-0.574	-0.023	-0.165	0.248	0.835	**
milk	-0.834	-0.252	0.012	0.123	0.471	1.169	*

[1] Weighting function: bisqaure, bandwidth adaptive about 20 nearest neighbour.

[2] Leung et al. F3 (2000a). Signif. codes: *** 0.001, ** 0.01, * 0.05, . 0.1.

The comparison of the OLS and GWR models (tab. 4) it points out how these last ones give a meaningful profit with the strong reduction of the value of the sum of residual squares (RSS) passing from OLS to GWR and as the test of nonstationarity (Anova) is also meaningful for both models. The value of the spatial correlation of the residuals (Moran's I) it also suffers a meaningful reduction in the second period were his value in the OLS model is very low, yet the GWR model allows a sensitive improvement of the results.

With the exclusion of the intercept, the only variable that always has positive values of the coefficient is the value of the cereals that also has the most elevated mean value in both models. Besides in the second models it increases of the 50% the middle weight of the cereals that passes from 0.255 to 0.376, while in the first period the F3 test (Leung et al., 2000a) it points out the meaningful presence of nonstationarity in the local coefficient of the GWR for all the independent variables, in the second model the cereals and the total of the vegetable productions are the variables that possess the more elevated values of significance in the presence of nonstationarity in the local coefficients.

Tab. 4. Comparison of OLS and GWR: values of productions models

	1993-95		2000-02	
	OLS	GWR	OLS	GWR
AIC	582.803	509.363	602.082	576.184
Anova[1]		5.77		5.34
p-value		< 0.00001		< 0.0001
Moran's I[2]	0.404	-0.040	0.157	-0.0492
p-value	< 0.00001	0.7373	0.0195	0.6822
RSS	108227.24	18815.86	67353.53	8519.1

[1] Brundson et al. (1999).

[2] Leung et al. (2000b).

These results point out how in the second period the cereals assumes a greater weight in the defining the total of the subsidies for hectare due to the CAP in all the examined regions, while it decreases the level of nonstationarity of the variables tied to the livestock pointing out like these last ones become less important to interpret the differences among the regions.

In the figures 5 and 6 the regions with the darkest color are those where the cereals are an important reference to define the amount of the total subsidies, but this doesn't want to say that they are also the regions where the value of the production of cereals is greater.

The values of the productions per hectare of UAA are pointed out in the figures 7 and 8. If we consider for example the Austrian regions we see that in two regions the value of the productions of cereals decreases between 1993-95 and 2000-02. Very probably this points out that the convenience toward cereals productions decreases for farmers in the regions not favourite. It is confirmed comparing the figures 9 and 10. In spite of this changes the cereals remains still an important source for subsidies, since at general level they have increased their incidence on the total (see tab. 1).

These transformations have produced new situations of competitiveness between the European regions that will condition in remarkable way the European agriculture in the future.

Finally the comparison between the figures 9 and 10 and the figures 5 and 6 shows how the answers of the GWR models allows to underline the nonstationarity contained in the spatial data; the distribution of the regions with different values of total subsidies for hectare in the first two figures is hardly referable to cluster of regions that have similar values, in the second case is more evident the presence on the territory of regions that have similar values.

4. Some conclusions

These results allow some reflections on CAP middle term Reform, adopted in 2003. We have already highlight the very positive aspects of the new measures, but it is useful to remember some of its points of weakness. There are many, but one assumes a notable importance. the support decoupled, tied up to the eligible land and calculated on the base of the direct payments perceived in 2000-2002, t constitutes a consolidation of the distribution of the agricultural expense at regional level in the Union. In other words it is recognized a privilege to regions and farmers that nowadays have the great benefits from the previous agricultural measures.

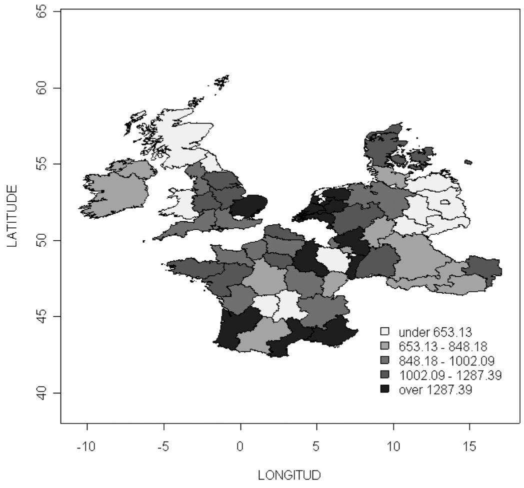

Fig. 1. GVA per ha (euro 1993-95)

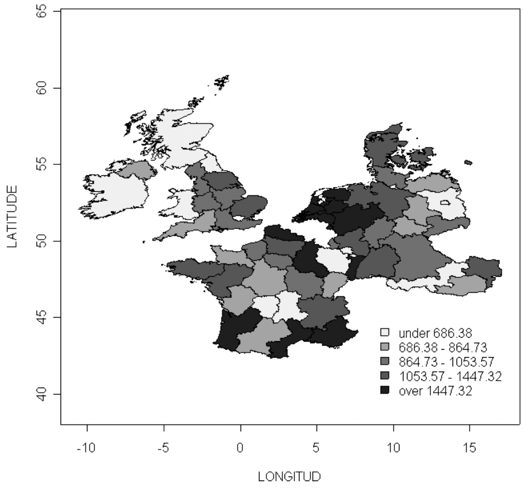

Fig. 2. GVA per ha (euro 2000-02)

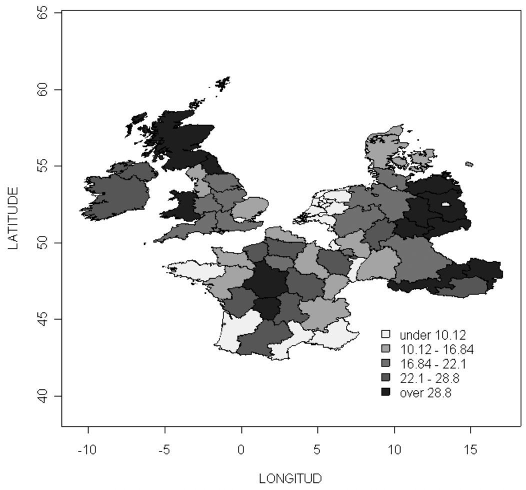

Fig. 3. Total subsidies per ha as percentage of GVA (1993-95)

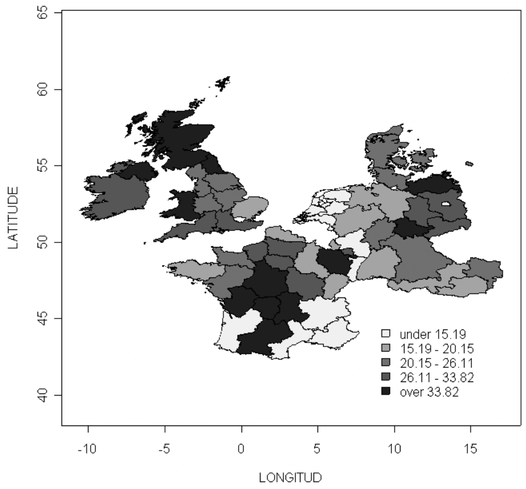

Fig. 4. Total subsidies per ha as percentage of GVA (2000-02)

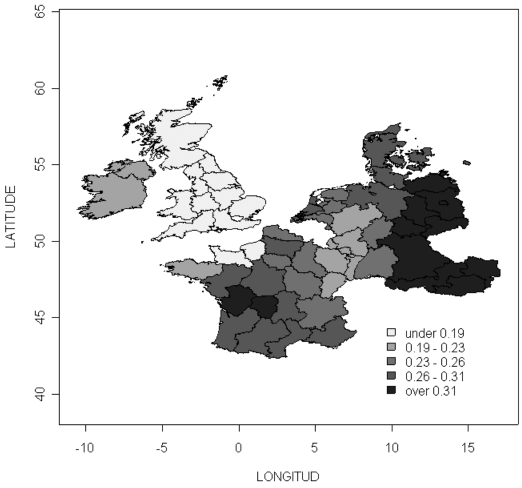

Fig. 5. Coefficient of cereals GWR model tab. 2 (1993-95)

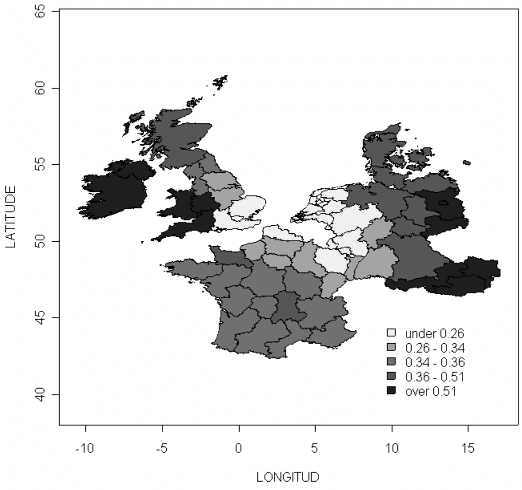

Fig. 6. Coefficient of cereals GWR model tab. 3 (2000-02)

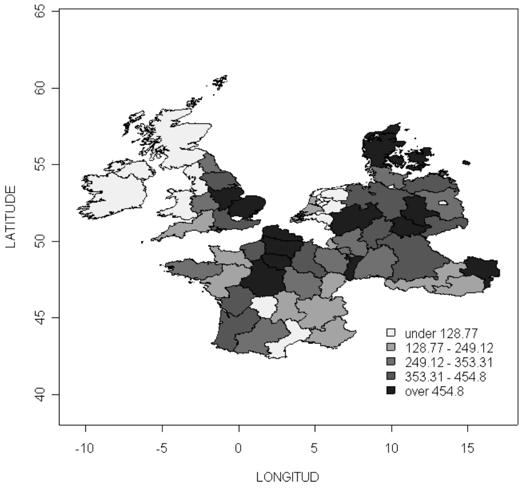

Fig. 7. Cereals value per ha/UAA (1993-95) (Euro)

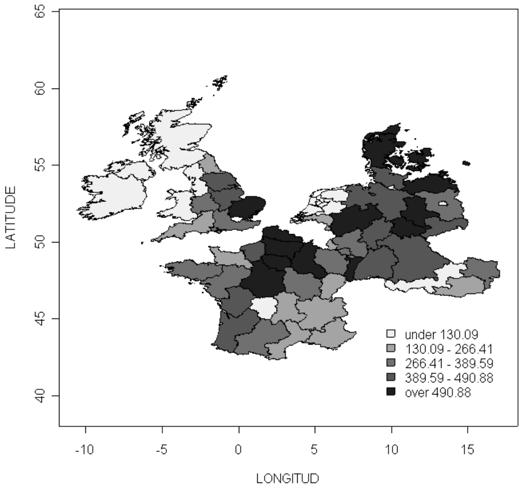

Fig. 8. Cereals value per ha/UAA (2000-02) (Euro)

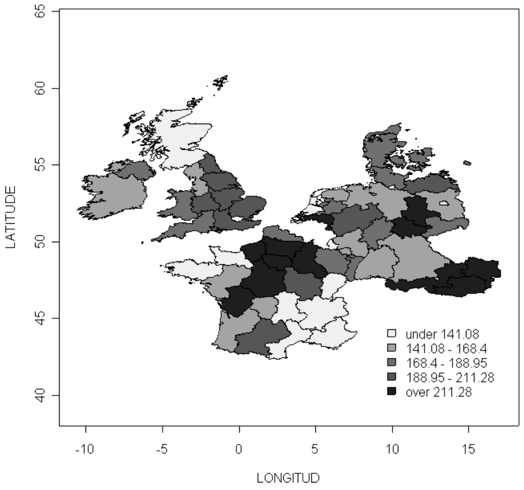

Fig. 9. Total subsidies per ha/UAA (1993-95) (Euro)

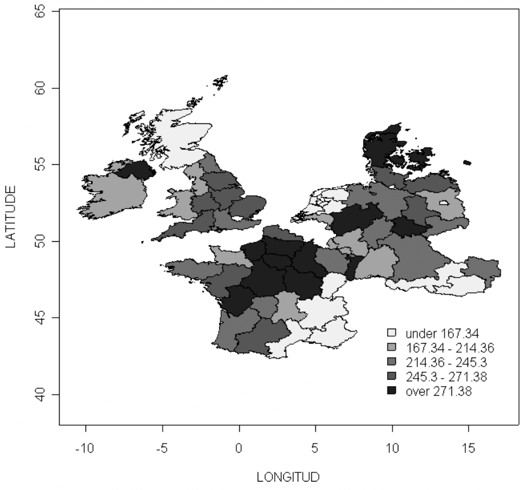

Fig. 10. Total subsidies per ha/UAA (2000-02) (Euro)

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Appendix A

Tab. A1. Analysed regions

IDN	NAME	IDN	NAME
AT1	Ost Osterreich	FR43	Franche-Comte
AT2	Sud Osterreich	FR51	Pays de la Loire
AT3	West Osterreich	FR52	Bretagne
DE1	Baden-Wurttemberg	FR53	Poitou-Charentes
DE2	Bayern	FR61	Aquitaine
DE3	Berlin	FR62	Midi-Pyrenees
DE4	Brandenburg	FR63	Limousin
DE7	Hessen	FR71	Rhone-Alpes
DE8	Mecklenburg-Vorpommern	FR72	Auvergne
DE9	Niedersachsen	FR81	Languedoc-Roussillon
DEA	Nordrhein-Westfalen	FR82	Provence-Alpes-Cote d'Azur
DEB	Rheinland-Pfalz	IE0	Ireland
DEC	Saarland	LU0	Luxembourg
DED	Sachsen	NL1	Noord-Nederland
DEE	Sachsen-Anhalt	NL2	Oost-Nederland
DEF	Schleswig-Holstein	NL3	West-Nederland
DEG	Thuringen	NL4	Zuid-Nederland
DK0	Danmark	UKC	North East
FR10	Ile de France	UKD	North West
FR21	Champagne-Ardenne	UKE	Yorkshire and The Humber
FR22	Picardie	UKF	East Midlands
FR23	Haute-Normandie	UKG	West Midlands
FR24	Centre	UKH	East of England
FR25	Basse-Normandie	UKJ	South East
FR26	Bourgogne	UKK	South West
FR30	Nord - Pas-de-Calais	UKL	Wales
FR41	Lorraine	UKM	Scotland
FR42	Alsace	UKN	Northern Ireland

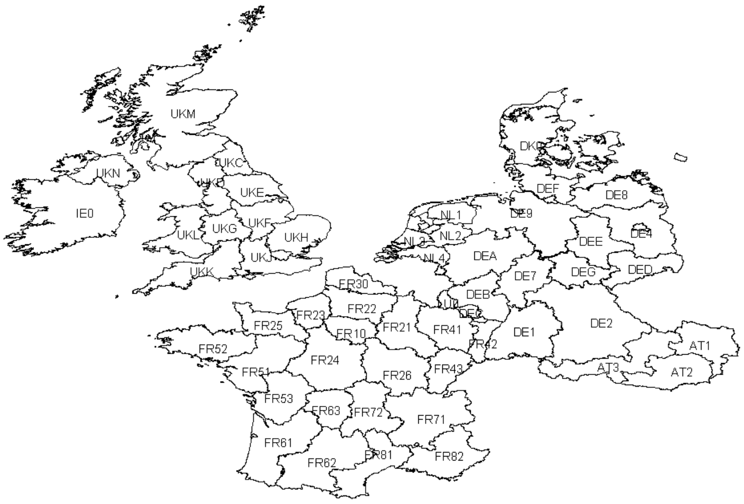

Fig. A1. Analysed regions