# Agricultural and Economic Convergence in the EU Integration Process: Do Geographical Relationships Matter?

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# AGRICULTURAL AND ECONOMIC CONVERGENCE IN THE EU INTEGRATION PROCESS: DO GEOGRAPHICAL RELATIONSHIPS MATTER?

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*Abstract* - **In the light of the reaffirmed importance of agricultural convergence within the integration process, the paper provides a preliminary investigation of the impact of the enlargement from the EU-15 to the EU-27 on agricultural real β-convergence and, with reference to the EU-27, of its relationship with economic catching-up process. The empirical analysis, based on a GWR approach, takes into account the regional spatial interdependences in estimating local parameters of convergence. The approach adopted allows to overcome the contradictory results from OLS estimations and parametric spatial econometric models pointed out by the literature and primarily connected to the existence of no unique convergence rate all over Europe. The analysis is based on a sample of 259 EU-27 regions at NUTS 2 level and is referred to the time period from 1991-2007.**

*Keywords* – **Regional convergence, Spatial analysis, GWR approach.**

## I. INTRODUCTION

The European Union (EU) has confirmed for the programming period 2007-13 the objective of convergence within the Cohesion policy [1]. Therefore, the convergence process of the EU regions is a matter of high political importance, it is at the basis of a successful regional policy, and it is also a financial strains strongly debated in the recent years [2, 3, 4, 5, 6, 7, 8, 9, 10]. The new Convergence objective for 2007-2013 is aimed at promoting growth-enhancing conditions and factors leading to real convergence for the least-developed Member States and regions [1, 11, 12].

Thus, the examination of the EU real convergence process is today indispensable for both political and financial reasons and it has to take into account some recent events that are of specific importance for the definition of the objective of the empirical analysis. Among them there are the EU enlargement, the reform of the CAP and of the Rural development policy and the adoption of the Strategic Guidelines for Cohesion [1].

The historic enlargement to 27 Member States has promoted the creation of new opportunities for the European territory that have a high potential in reducing gap in income levels of countries belonging to the integrated regions and those of the whole EU-27 [13]. Most regions receiving convergence support, particularly of the New Member States, are agricultural regions. Therefore, the growth in the sector is recognised as factor of acceleration of regional economic and income development. For this reason the CAP measures have changed over time at the evolving objectives of the cohesion policy. The recent emphasis on rural development interventions underlines the EU concern for the positive impact on convergence of the benefits, or positive external effects, produced by agriculture in addition to the market value of its production [14]. This view also support decoupling in the sense that agricultural subsidies and regional growth are understood as negatively correlated.

In the light of these considerations, the paper provides a preliminary estimation of the impact of the enlargement from the EU-15 to the EU-27 on agricultural real β-convergence and, only with reference to the EU-27, of its relationship with economic catching-up process. The process is analysed taking into account the regional spatial interdependences. The analysis is based on a sample of 259 EU-27 regions at NUTS 2 level, of which 204 are of the EU-15, and is referred to the time period from 1991-2007.

The approach to the empirical analysis has been selected considering the importance of the territorial dimension given by the Community to cohesion policy. Concerning convergence, the assertion suggests the need for understanding how disparities evolve in each region. This observation does not mean that territorial units have to be understood as "isolated islands". The empirical literature has clearly shown that spatial dependence across regions matters in catching-up process. A series of studies have drawn attention to specification problems found in estimating the standard OLS growth regressions pointing out that the problem of a bias regression coefficient or invalid significant tests is partly related to substantive spatial spillovers arising from migration of labour and human capital, technological and knowledge spillovers and commuter flows [15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29]. In order to combine the need for estimating locally different parameters of β-convergence considering spatial dependence of regions, the empirical analysis has made reference to the non-parametric technique of Geographically Weighted Regression (GWR) developed by Brundson, Charlton and Fotheringham [30].

The approach adopted also allows to overcome the contradictory results from OLS estimations and the parametric spatial econometric models, that is the spatial lag and spatial error approaches, that the empirical literature points out and primarily connects to the existence of no unique convergence rate all over Europe [22].

Despite the improvements the GWR approach allows to achieve, a few convergence studies of European regions are based on the methodology. Concerning agriculture, only Bivand and Brunstand [14] have investigate the interaction between agricultural policy and regional growth on the basis of this approach. However, their analysis is referred to Western Europe and does not take into account integration. Thus, the value added of the paper lies in the new approach adopted to a topic, agricultural convergence and integration and its relationship with economic convergence, poorly investigated.

The outline of the paper is as follows. Section 2 describes the methodology adopted, section 3 illustrates results and section 4 concludes.

## II. METHODOLOGY AND DATA SET

Geographically weighted regression is a technique to include a spatial variation of the regression coefficients [30]. In convergence analysis, the regression equation is similar to an OLS regression that estimates a global coefficient of convergence over the whole data set according to a typical neoclassical equation in the form:

$$\frac{1}{T}\ln\left(\frac{y_{iT}}{y_{i0}}\right) = \beta_0 + \beta_1 \ln(y_{i0}) + \mu_i \quad (1)$$

where y is the agricultural (or economic) productivity, 0 the initial year, T the final year, $i$ the regions, $\beta_j$ (j=0, 1) the coefficients ($\beta_1$ the coefficient of convergence) and $\mu_i$ is a disturbance term [31, 32, 33, 34].

However, GWR estimates a local and not a global coefficient of convergence for each region ($i$) in the data set according to the model written in the form:

$$\frac{1}{T} ln\left(\frac{y_{iT}}{y_{i0}}\right) = \beta_{0i} + \beta_{1i}\, ln(y_{i0}) + \mu_i \quad (2)$$

with $\beta_i$ the unknown parameter vector which is function of location $i$.

As in equation (2.2) there are more unknown parameters than degrees of freedom, the local estimates are made using weighted regressions. In other words, in the calibration process the variables are weighted in accordance with the distance between them. Algebraically, the GWR estimator of the $i^{th}$ region is expressed by:

$$\hat{\beta}_i = (X' W_i X)^{-1} X' W_i y \quad (3)$$

with

$$\hat{\beta}_i = (\hat{\beta}_{0i}, \hat{\beta}_{1i}) \quad (4)$$

an array of the regression coefficients and $W_i$ the diagonal weighing matrix

$$W_i = \begin{pmatrix} w_{11} & 0 & \cdots & 0 \\ & w_{22} & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & w_{nq} \end{pmatrix} \quad (5)$$

where $w_{ij}$ is the weight of the data at region $j$ on the calibration of the model around region $i$ whose value is assumed to be an inverse function of the distance (bandwidth) between region $i$ and $j$.

The weight matrix specification implies the bandwidth selection. Among the possible options, it has been chosen an adaptive weighting scheme and a bi-square function (Fotheringam et al., 2002) in the form of:

$w_{ij} = [1-(d_{ij}/b)^2]^2$ if $d_{ij} < b$ (6)

= 0 otherwise

It is adaptive in the sense that the distance expresses the number of regions to retain within the kernel "windows" irrespective of the geographic distance. The optimal number of regions has been selected by the Akike Information Criterion. To test the GWR model the analysis has followed the global test of non-stationarity, the pseudo-F statistic, introduced by Brunsdon et al. [35] that compares a regression of $y$ on $X$ with sum of squared residuals to a geographically weighted regression. If the null hypothesis of stationarity is rejected, the GWR model is appropriated. Beside, the non-stationarity of all regression coefficients has been checked by a Monte Carlo simulation in order to understand whether one parameter is non-stationary [30].

The analysis has required data on regional agricultural and total gross value added (GVA). They have been taken from Cambridge Econometrics' European regional database which has allowed to enlarge as long as possible the time series, from 1991-2007, according to the needs of the investigation of a long term process such as that of convergence, and to make reference to the NUTS2 EU-27 regions. However, Cambridge Econometrics' annual time series for the labour market is in terms of number of workers bringing about a possible overvaluation of labour productivity particularly in agriculture due to high share of part-time and seasonal jobs that characterise the sector. Standard labour units provided by EUROSTAT would have been a more suitable dataset but the number of regions and the time series would have been reduced significantly compromising the explanation capacity of the analysis.

## III. RESULTS

### *III.A. EU Enlargment and Agricultural Convergence*

Table 1 illustrates the results of testing agricultural real convergence across the 204 EU-15 regions and the 259 EU-27 territorial units for the period from 1991-2006. The estimations has a good explanatory power. The pseudo-F test is highly significant and the R-squared proves the model fit for every region in both the regressions.

Furthermore, GWR parameters are significantly non-stationary.

Tab. 1a GWR model for agriculture - EU-15

| Coefficient | Minimum | Lower quartile | Median | Upper quartile | Maximum | Global OLS |
|---|---|---|---|---|---|---|
| $a_{0i}$ (ns ***) or $a_0$ | -0.053 | 0.091 | 0.121 | 0.184 | 0.235 | 0.127 |
| $\beta_{1i}$ (ns ***) or $\beta_1$ | -0.066 | -0.053 | -0.032 | -0.024 | 0.022 | -0.034 |
| $R^2_i$ or $R^2$ | 0.002 | 0.300 | 0.600 | 0.844 | 0.985 | 0.473 |

AIC = - 1128.559; Adaptative bandwidth = 27/204; Global test of non-stationarity: F = 4.808***

Notes: ns: Monte Carlo non-stationarity test; $R^2$: coefficient of determination; $R^2_i$: local coefficient of determination; F = empirical *F-value*; *** p-value < 0.001.

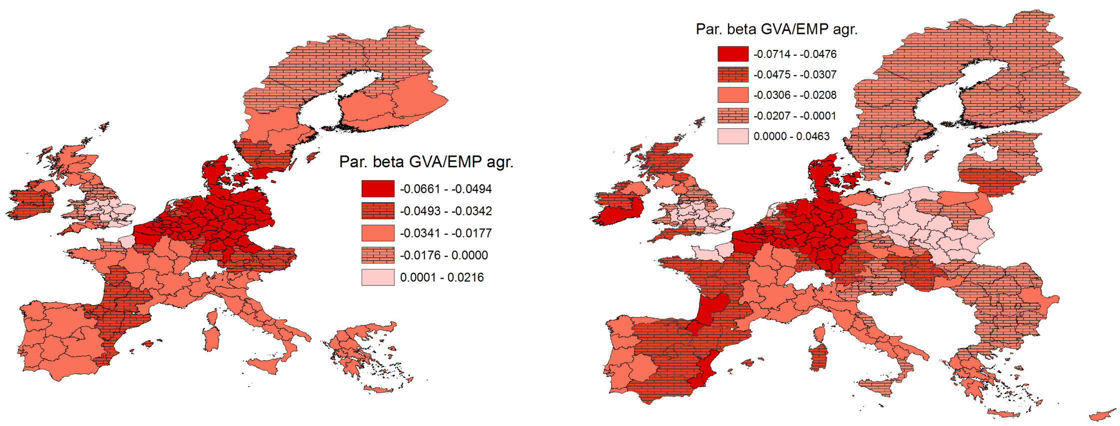
Tab. 1b GWR model for agriculture - EU-27

| Coefficient | Minimum | Lower quartile | Median | Upper quartile | Maximum | Global OLS |
|---|---|---|---|---|---|---|
| $a_{0i}$ (ns ***) or $a_0$ | -0.070 | 0.071 | 0.098 | 0.148 | 0.258 | 0.075 |
| $\beta_{1i}$ (ns ***) or $\beta_1$ | -0.071 | -0.040 | -0.025 | -0.013 | 0.046 | -0.016 |
| $R^2_i$ or $R^2$ | 0.131 | 0.480 | 0.680 | 0.843 | 0.984 | 0.314 |

AIC = - 1355.054; Adaptative bandwidth = 19/259; Global test of non-stationarity: F = 5.994

Notes: ns: Monte Carlo non-stationarity test; $R^2$: coefficient of determination; $R^2_i$: local coefficient of determination; F = empirical *F-value*; *** p-value < 0.001.

The global OLS models show that the EU regions are catching-up (βs have negative sign) and that with the integration of the New Member States the speed of the process has significantly reduced, with the parameter of convergence that has decreased from –0.034 to –0.016.




a. EU-15

b. EU-27

Fig. 1 – Spatial structure of the GWR parameters of convergence in the EU agriculture

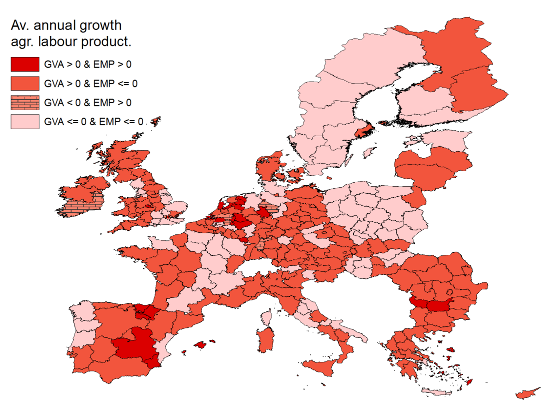



Fig. 2 – Agricultural GVA and employment growth (1991-2007)

Conditioning the regression equation with the relationships across space in the two samples, it emerges the operational of different dynamics of growth across the territorial units.

The gap between the minimum and maximum value increases when the New Member States are included. Thus, contrary to what suggested by the global OLS estimation, not all the regions are catching-up and the number of these territorial units rises at the enlargement of the EU (Figure 1).

The additional diverging regions are mainly in the New Member States and refered to a large number of Polish regions. To these, the South England territorial units have to be added.

Even if the optimal bandwidth has changed the classification of the EU-15 and the EU-27 regions seems to be robust.

The only relevant changes are in the regions sharing the borders with the New Member States. The analysis suggests that spillovers matters in the process of convergence and underlines the need for a better investigation of the aspect.

Furthermore, considering the dynamics of the agricultural typologies a good degree of homogeneity within the convergence club has been pointed out (Figure 2)

The spatial structure of the parameter of convergence provided by Figure 1 gives an immediate visual impression of the fact that nearby located areas show a similar speed of catching-up and these groups might be interpreted as convergence clubs characterised by conditions that are not very different, as suggested by Figure 2, and therefore they converge to the same steady state. Contrary to the a-priori process of definition of the clubs followed by the literature, GWR approach allows to identifies these sub-groups on the basis of the similarity in the values of the parameters of convergence and for this reason the clusters remain more stable at the change of the sample and without significant changes in the bandwidth.

As far as the regions with the highest speed of convergence are concerned, it should be noticed that these values, referred to the German, Belgian, Dutch regions, Denmark and a small number of French regions, might be partly affected by the strong commuting from rural to urban regions that characterises the area.

A final consideration refers to the intercept that covers a range between –0.053 and 0.235 in the EU-15 GWR estimation and that widens considering the EU-27 territorial units assuming the minimum value of –0.075 and a maximum value of 0.258. The result underlies that the EU regions are characterised by different values of the initial level of technology, of growth rates of technological progress and steady states values and the gap has increased with the enlargement.

*III.B. Agricultural and Economic Convergence in the EU-27*

The results of the estimation of the GWR for the total economy are listed in Table 2.

Tab. 2 – GWR model for the EU-27 economy

| Coefficient | Minimum | Lower quartile | Median | Upper quartile | Maximum | Global OLS |
|---|---|---|---|---|---|---|
| $a_{0i}$ (ns ***) or $a_0$ | -0.212 | 0.012 | 0.591 | 0.095 | 0.194 | 0.069 |
| $\beta_{1i}$ (ns ***) or $\beta_1$ | -0.089 | -0.023 | -0.013 | 0.002 | 0.064 | -0.015 |
| $R^2_i$ or $R^2$ | 0.036 | 0.676 | 0.892 | 0.954 | 0.996 | 0.522 |

AIC = - 1719.360; Adaptative bandwidth = 12/259; Global test of non-stationarit

Notes: ns: Monte Carlo non-stationarity test; $R^2$: coefficient of determination; $R^2_i$: local coefficient of determination; F = empirical *F-value*; *** p-value < 0.001.

The global F-test of non-stationarity and that on the single parameters prove that the estimation of regionally different regression coefficients is appropriated.

On the basis of the global OLS model it should be concluded that the speed of agricultural and total convergence rate are close: -0.016 for the former and –0.015 for the latter. However, also in this case there is no unique convergence rate all over Europe and on the total the gap between the minimum and the maximum values is slightly grater in the economic context than in the agricultural sector. Furthermore, the speed of the process of catching-up reaches the highest value in the agriculture while the sector shows lowest value of divergence. The number of divergent regions in the overall economy increases and, in comparison with what happens for the agricultural sector, they also consists of a large number of the UE-15 territorial units and to a less extent of New Member States regions (Figure 3)

Comparing the spatial structure of the parameter of convergence in agriculture and on the total, it immediately emerges that there is no clear overlapping between the intensity of the two catching-up processes. The aspect is confirmed by the Spearman Rank Correlation Coefficient that has been adopted to discover the strength of the link between the two sets of data. The coefficient is given by the following formula:

$$\rho = 1 - \frac{6(\Sigma d^2)}{N(N^2 - 1)} \qquad (7)$$

where 6 is a constant, d refers to the difference between the region ranks on the coefficient of convergence in agriculture and on the total and N is the number of regions in the sample. The t-test statistic has been adopted to test the significant level of the indicator that has resulted very strong. The Spearman Rank Correlation Coefficient has resulted equal to –0.0317. The negative sign suggests an inverse relationship between the two data set, but the value approaching 0 underlines that there is no correlation between them. The fact can be partly due to the decreasing role of agriculture in the overall process of income formation. In this case, the maturity stage of development of agriculture implies its low capacity to affect the economic performance. This aspect is in part confirmed by Figure 4.

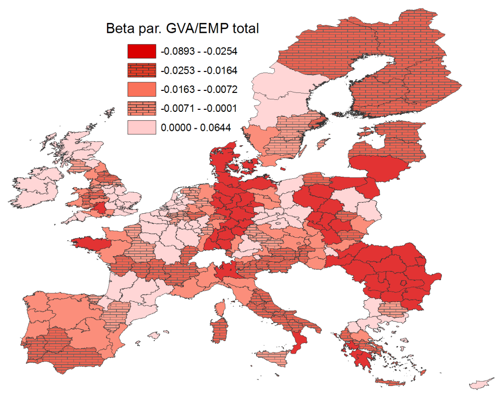
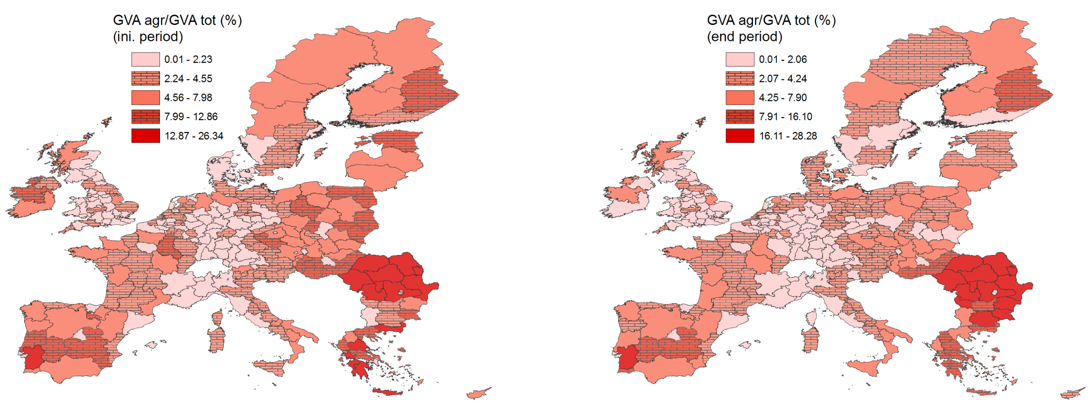



Fig. 3 - Spatial structure of the GWR parameters of convergence in the EU-27 economy




a. Initial period b. Final period

Fig. 4 - Share of agricultural GVA on total (1991-2007)

However, it should be noticed that the very low value of the Spearman Rank Correlation Coefficient could be the result of more complex territorial interactions particularly referred to the reduced attraction capacity of the agriculture labour force by the other sectors in the same and other regions that weakens the economic and agricultural nexus.

## IV. CONCLUSIONS

The GWR approach has allowed to underline that there is no unique convergence rate across EU regions in both agriculture and the overall economy and that there is no correlation between the speed of the two processes at the regional level.

The analysis shows a well defined model "centre-periphery" of the regional disparities and within the "centre" different speeds of catching-up. The asymmetric nature of the regional problems of the EU is the result of both a geographic proximity and an economic process that have a root partly in the period pre-enlargement and partly in the integration process. This latter process might have brought about two sets of counterbalancing forces, one supporting convergence and the other divergence. According to the literature, the factors at the basis of the convergence process should be determined by a number of automatic balancing processes associated with operational free markets whose effects are reinforced by the wider factor mobility [36] while the forces supporting divergence might be those referred to systemic centre-periphery effects. According to this perspective, scale economies, localization economies, intra-industry exchanges and leading positions on the market, lack of competitiveness in the marginal regions, selective migration, lost of political power at the macro level and cumulative causation process [37] have a significant role. The analysis developed has allowed to introduce a new element of understanding of the process of convergence in the EU-27. In fact, in addition to the traditional factors also the geographical proximity seems to have a key a importance in affecting the intensity and the direction of the catching-up process.

All these factors deserve a specific attention in the forthcoming analysis particularly in the light of the likely policy options that should be introduced at the territorial level and by the importance of the multi-regional policy interventions within the framework of the Rural development policy and in the underway process of review of the structural and regional EU policy.

The analysis has underlined a reduction in the speed of convergence and a widening of the gap between the minimum and maximum value of the parameters of convergence passing for the sample of EU-15 to EU-27 regions and are mostly the territorial units of the New Member States that show a divergent process or the lower speed of catching-up. In this perspective, the neoclassical approach that supports integration as an instrument of convergence, through the specialization in productions and export of goods and services with a comparative advantage, seems not to find confirmation in the agricultural sector.

The result suggests the need for the analysis of the determinants of agricultural growth and in particular of the role of the CAP. In this context, a key area of understanding is the impact of direct payments and the structural components of the CAP, on the one side, and of the convergence funds, on the other side, on the catching-up process. This is important not only because a policy reform process is underway but particularly in the light of the conflicting positions expressed by the empirical investigations.

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