

## Convergence in Agriculture: Evidence from the European Regions

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### Abstract

*Although there have been numerous studies on regional convergence, agriculture has received far less attention. In this study, the intention is to augment the existing literature by testing for convergence in agricultural productivity among the EU-26 regions. A low rate of absolute convergence is estimated over the period 1995-2004 whilst evidence of club convergence is apparent.*

**Key Words:** *Absolute and Club Convergence, Agriculture, European Union Regions*

**JEL Classification:** Q10, O47, C2

### Introduction

In recent years there has been a proliferation of studies on regional convergence. However, the recent explosion of interest in growth and convergence has not followed a uniform path. Instead, several distinct types of convergence have been suggested in the relevant literature, each being analysed by distinct groups of scholars employing different methods. As part of the aforementioned efforts, economic convergence has been tested across the regions of the European Union (hereafter EU)<sup>1</sup>.

The question of regional convergence, expressed in terms of economic and social cohesion, is mentioned in the Preamble of the Treaty of Rome and has become one of the major goals of the EU. This is formulated in the Single European Act (title XIV, currently title XVII). According to article 158 of the Rome Treaty “reducing disparities between the levels of development of the various regions” is one of the primary objectives of EU development policies. The Treaty of Rome also expresses a commitment to “ensure a fair standard of living for the agricultural community, particularly by increasing the individual earnings of persons engaged in agriculture” while increased productivity in agriculture is one of the main goals of the Common Agricultural Policy (hereafter CAP); a policy which still dominates the EU budget<sup>2</sup>. A swift glance at various EU-

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ROSTAT publications about agriculture (EUROSTAT, 1999, 2007) reveals that this activity does not seem to be evenly distributed across the EU countries. For example, France contributes 19.1% in total agricultural GVA, followed by Italy (14.7%) and Spain (12.2%). Agriculture accounts for about 20%, on average, of the working population in Greece and only 2% in Belgium and the UK. Substantial differences are also detected across the regional divisions of the EU. Taking agricultural employment in 1988 as an illustration, the percentage employed in agriculture ranged from 45.9% in the region of Central Greece down to 0.2% in the Brussels-Gewest region and 0.3% in Bremen. In terms of regional agricultural labour productivity (hereafter RALP), about 46% of the EU-26 regions are below the European average with the majority of them located in Southern Mediterranean and Eastern Europe. Northern regions, especially in the UK and the Netherlands are generally characterised by a ‘cost-effective’ agricultural sector and display a level of labour productivity two times higher than regions located in Southern and Eastern countries.

Nevertheless, agriculture has rarely received attention as testing grounds for the hypothesis of economic convergence<sup>3</sup>. There is, however, an enormous interest from policy-makers at all levels (local, regional, national and / European) about productivity convergence in agriculture. More than ever, policy makers need independent and encompassing studies, which can provide critical new information about the specific pattern that prevails across the European regions. Thus, drawing on theoretical ideas and debates about regional convergence, this paper aims to shed some further light on whether or not there is a pattern of convergence in agricultural productivity across the European regions.

This effort is organised in the following manner. The context, in which the paper’s main question emerges, *viz.* conceptual and empirical approaches to convergence, is discussed in Section II. Section III presents the econometric results. Finally, in Section V the implications of the results for the debate concerning convergence across the EU regions are assessed and we argue that might afford an interesting policy conclusion.

### **Regional Convergence: Theoretical and Empirical Approach**

Although the early ‘seeds’ of the convergence question can be found in several contributions of economic historians, such as Kuznets (1955), Rostow (1960), Gerschenkron (1962) and Gomulka (1971), all of which recognise how backward countries tend to grow faster than rich countries, the conceptual apparatus derives from the standard neo-classical theory, as this is formulated by Solow (1956). This model, essentially, describes a mechanism by which regions reach ‘*steady-state*’ equilibrium. Despite the restrictive conditions of this model two important conclusions can be drawn. First, regions will converge towards a common ‘*steady-state*’ if the growth rate of technology, rate of investment and rate of growth of the labour force are identical across regions. Second, the further a region is ‘below’ its ‘*steady-state*’, the faster this region should grow, which leads to the more general prediction that poorer regions will grow faster than richer regions.

Assuming perfect competition, zero transportation costs, full employment, a single homogenous product and constant returns to scale production functions, which are identical across regions, factors are paid the value of their marginal products. Hence, the

wage (equal to marginal product of labour) is a direct function of the capital-labour ratio and the marginal product of capital (return to capital) is an inverse function of the capital-labour ratio.

Within this model, movements of factors between regions are induced by differences in the returns to factors of production. The assumption of diminishing marginal productivity of capital ensures that regions with a high (low) capital-labour ratio will exhibit low (high) marginal product of capital. Similarly, regions with a high (low) capital-labour ratio offer high (low) wages. In such circumstances it is argued that labour will have a propensity to migrate away from low wage regions towards high wage regions while capital will move in the opposite direction, away from the more prosperous regions where its marginal product is low, towards lagging regions where additional capital investment is more profitable. These factor flows will boost growth in output per worker in lagging regions. Thus, capital and labour migrate in response to interregional differences in factor returns and these factor movements will continue until factor returns are equalised in each region. The overall outcome is, therefore, one in which an interlocking and mutually – reinforcing set of processes (i.e. diminishing returns, labour migration, capital mobility and access to the same level of technology) erode regional economic disparities, leading to regional convergence.

It is reasonable to assume that labour and capital can more easily migrate between regions rather than across nations. It might be argued, therefore, that a network of regional economies provides an appropriate ‘laboratory’ for testing the neoclassical predictions of convergence. Barro and Sala-i-Martin (1995), note that convergence is more likely to occur between regions rather than national economies for precisely this reason. Although recognising the existence of some structural differences between regions they argue that these differences are likely to be small or even insignificant, compared to differences between nations.

Absolute or  $\beta$ -convergence is now used generally to describe the situation of a ‘poor’ economy exhibiting a *tendency* to grow faster than a ‘rich’ economy leading eventually to the equalisation of per capita output across economies. This framework not only provides a practical approach to the measurement of convergence but also an expression for the speed at which convergence takes place.

The first statistical test of the hypothesis that poor economies will catch up with rich economies is found in Baumol (1986), generally regarded as a major contribution to the convergence debate. Baumol (1986) placed emphasis on the dictum that convergence is identical with a negative relation between an initial level and growth rate of per capita output. A central tenet of Baumol’s thesis is that convergence is feasible if ‘poor’ economies exhibit a tendency to grow faster than ‘rich’ economies. More formally,

$$g_i = a + by_{i,0} + \varepsilon_i \quad (1)$$

where  $y_{i,0}$  is the natural logarithm of output per worker at some initial time for the  $i^{\text{th}}$  region,  $a$  is the constant term,  $b$  is the convergence coefficient and  $\varepsilon_i$  is the random error term<sup>4</sup>. If output per worker  $Y_{i,T}$  grows as  $Y_{i,T} = e^{g_i} Y_{i,0}$ , then  $g_i = y_{i,T} - y_{i,0}$ , where  $T$  is the terminal time. The condition for convergence requires that the first derivative of equation (1) is negative. Thus:

$$\frac{\partial g_i}{\partial y_{i,0}} = b < 0 \quad (2)$$

The intuition behind this argument is that regions with relatively low initial output per worker grow faster than those with relatively high output per worker, indicating that 'poor' regions catching up with 'rich' regions. Romer (1996) describes perfect convergence as occurring when  $b = -1$  while at the other extreme, a value of  $b = 0$  indicates that the regions included in the data set may even exhibit divergence. Alternatively,  $b = 0$  implies  $g_i = a$ , which can be considered as an indication of an autonomous growth rate that maintains income differences across regions. A distinction is made in the literature between the convergence coefficient  $b$  and the speed of convergence  $\beta$ . Following Barro and Sala-i-Martin (1995) the convergence coefficient  $b$  may be expressed as follows:

$$b = -(1 - e^{-\beta T}) \quad (3)$$

where  $T$  is the number of years included in the period of analysis. The term for  $\beta = -\frac{\ln(b+1)}{T}$  indicates the speed at which regions approach the steady-state value of output per worker over the given time period, i.e. the average rate of convergence. If  $b < 0$  then  $\beta > 0$ , indicating that a higher  $\beta$  corresponds to more rapid convergence.

In his seminal paper Baumol (1986) introduced an alternative concept of convergence, that of *club convergence*, in order to describe a subset of national economies within the world economy, which demonstrate the property of convergence. Analysing 72 countries between 1950 and 1980, Baumol (1986) concludes that, in fact, 'there is more than one convergence club' (p. 1080) in the sense that income levels converged within the industrialised countries, the centrally planned economies and the middle-income market economies, but not within the group of low-income countries. Moreover, between these groups income levels appeared to diverge. Subsequently, Baumol and Wolff (1988), demonstrate that middle income countries (17 out of 72 countries included in the sample) have grown the fastest and the poorest countries have diverged from the others<sup>5</sup>.

In order to detect club convergence, Baumol and Wolff (1988) reformulate the test for absolute convergence using the following model:

$$g_i = a + b_1 y_{i,0} + b_2 y_{i,0}^2 + \varepsilon_i \quad (4)$$

This quadratic function is illustrated in Figure 1, and is drawn on the assumption that  $b_1$  is positive and  $b_2$  negative, which are the conditions required for the existence of a convergence club. Growth reaches a maximum ( $g^*$ ) when

$$\frac{\partial g_i}{\partial (y_{i,0})} = b_1 + 2b_2(y_{i,0}) = 0 \quad (5)$$

Solving equation (5) for  $y_{i,0}$  yields:

$$y^* = \frac{-b_1}{2b_2} \quad (6)$$

where  $y^*$  is the level of output per worker that corresponds to maximum growth.

It is this turning point which is used to identify members of the convergence club. For regions with an initial level of output per worker in excess of the threshold  $y^*$ , growth is inversely related to the initial level of output per worker. It may therefore be argued that these regions constitute a 'convergence club' by exhibiting  $\beta$ -convergence. The opposite holds for regions where output per worker lies below  $y^*$ . In this case, growth is positively related to initial output per worker (provided that  $b_1 > 0$  of course). Once this knowledge is introduced, it comes as no surprise that the initial conditions, as expressed in terms of output per worker, of the regions in the convergence club are likely to be similar. In other words, a convergence club is unlikely to consist of regions with markedly different levels of output per worker; all must lie within a range that is equal to, or above, the threshold value  $y^*$ .

Consider two regions, A and B growing at the *same* rate ( $g_A = g_B$ ), but  $y_{A,0} - y^* < 0$  and  $y_{B,0} - y^* > 0$ , implying that  $y_{A,0} - y_{B,0} < 0$ . If these two regions continue to grow at the same rate, i.e. if  $(g_A - g_B)_t = 0$ , then  $(y_A - y_B)_t < 0$  as  $t \rightarrow \infty$ , which indicates that region A is unable to close the gap with region B. Convergence between these two regions is feasible only if region A grows faster than region B, i.e. if  $(g_A - g_B)_t > 0$ , as  $t \rightarrow \infty$ . In this context it is reasonable to assume that the rates of convergence will differ between the regions included in a convergence-club and the regions excluded from the club, i.e.  $b_c - b_{nc} \neq 0$  and  $\beta_c - \beta_{nc} \neq 0$ . Given that  $b < 0$  implies convergence, then it follows that  $b_c - b_{nc} < 0$  and  $\beta_c - \beta_{nc} > 0$ , i.e. that the regions in the club converge faster compare to the regions excluded from the club. It might be argued, therefore, that a relatively high (low) level of initial labour productivity, defined as  $y^* - y_{i,0} < 0$  ( $y^* - y_{i,0} > 0$ ), ensures  $\beta$ -convergence (divergence). This is consistent with Baumol's description of the convergence club as 'a very exclusive organisation' (p. 1079).

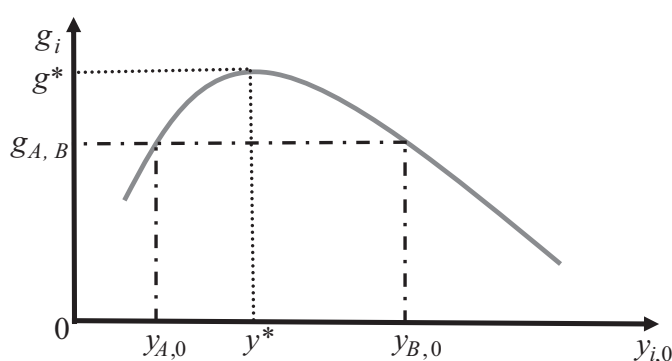


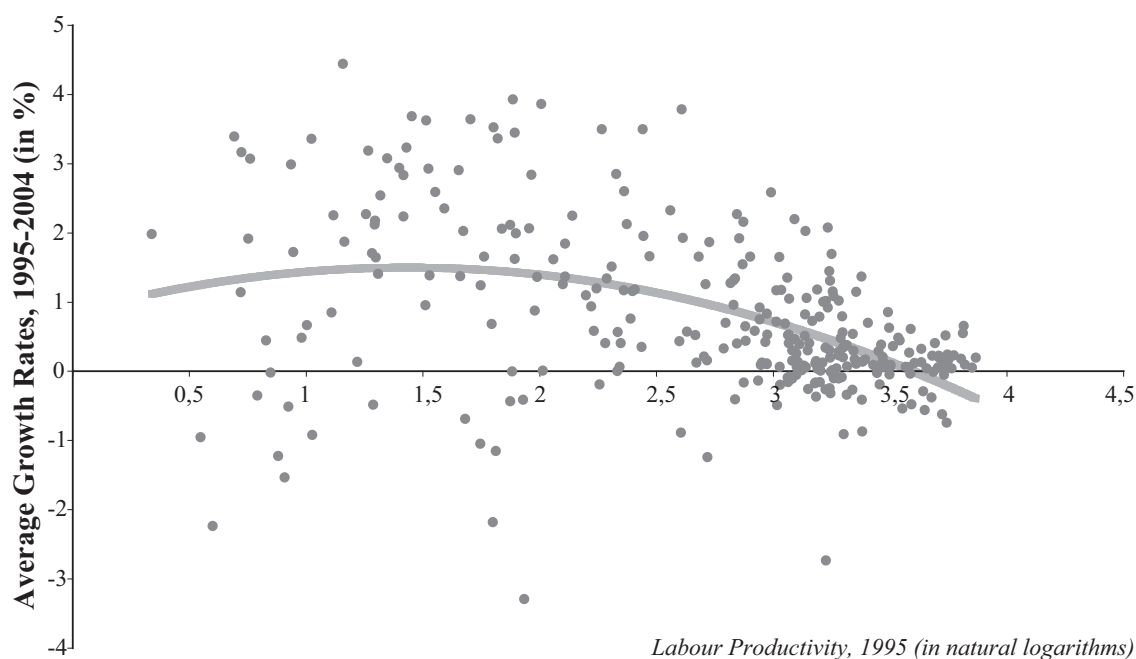
Figure 1: Club Convergence

### Testing for Absolute and Club Convergence across the EU-26 regions

In this paper we exploit data on GVA per worker in agriculture since this measure is

a major component of differences in the economic performance of regions and a direct outcome of the various factors that determine regional ‘competitiveness’ (Martin, 2001). The regional groupings used in this paper are those delineated by EUROSTAT and refer to 258 NUTS-2 regions. The EU uses NUTS-2 regions as ‘targets’ for convergence and defined as the ‘geographical level at which the persistence or disappearance of unacceptable inequalities should be measured’ (Boldrin and Canova, 2001, p. 212). Despite considerable objections for the use of NUTS-2 regions as the appropriate level at which convergence should be measured, the NUTS-2 regions are sufficient small to capture sub-national variations (Fischer and Stirböck, 2006). The data cover the period 1995 to 2004, a sample period that might be considered as somehow short. However, Islam (1995) points out equation (1) is valid for shorter time periods as well, since is based on an approximation around the ‘steady-state’ and supposed to capture the dynamics toward the ‘steady-state’.

The potential for  $\beta$ -convergence is indicated in Figure 2, which shows a scatterplot of the average annual growth rate against the initial level of RALP. Casual inspection of the data in Figure 2 provides some indication of an inverse relationship between the average annual growth rate and initial level of labour productivity. Regions above an approximate threshold of 2.5 (about 12,000 Euros) for initial labour productivity could be described as exhibiting absolute convergence.



**Figure 2:**  $\beta$ -convergence, EU-25 regions, 1995-2004

As a first step in the process of assessing convergence in the EU-25 regions a test for absolute  $\beta$ -convergence across all regions is carried out, using Ordinary Least Squares (hereafter OLS) to estimate equation (1). The results are set out in Table 1 and show that  $b_1 > 0$ , thus indicating some signs of absolute convergence over the period 1995 to

2004. Attention should be drawn to the fact that the rate of convergence is relatively low, estimated at 0.51% per annum.

The second step is to test for club-convergence. The obtained results are consistent with the presence of a sub-group of regions demonstrating convergence properties in that the signs of the coefficients are as expected;  $b_1 > 0$  and  $b_2 < 0$ , and both statistically significant.

**Table 1.** Absolute and Club Convergence, 1995-2004

Depended Variable: $g_i$ , OLS Sample: 258 EU-25 NUTS-2 Regions		
$a$	0.3016* (5.018)	-0.2997* (-2.341)
$b_1$	-0.0527* (-2.569)	0.5115* (4.682)
$b_2$		-0.1163* (-5.251)
Implied $\beta$	0.0054*	
Implied $y^*$		2.1982*
LIK	0.7553	31.9193
AIC	2.4893	- 55.8386
SBC	9.5952	- 41.6267

Notes: Figures in brackets are t-ratios. \* indicates statistical significance at 95% level of confidence. AIC and SBC denote the *Akaike* and the *Schwartz-Bayesian* information criteria.

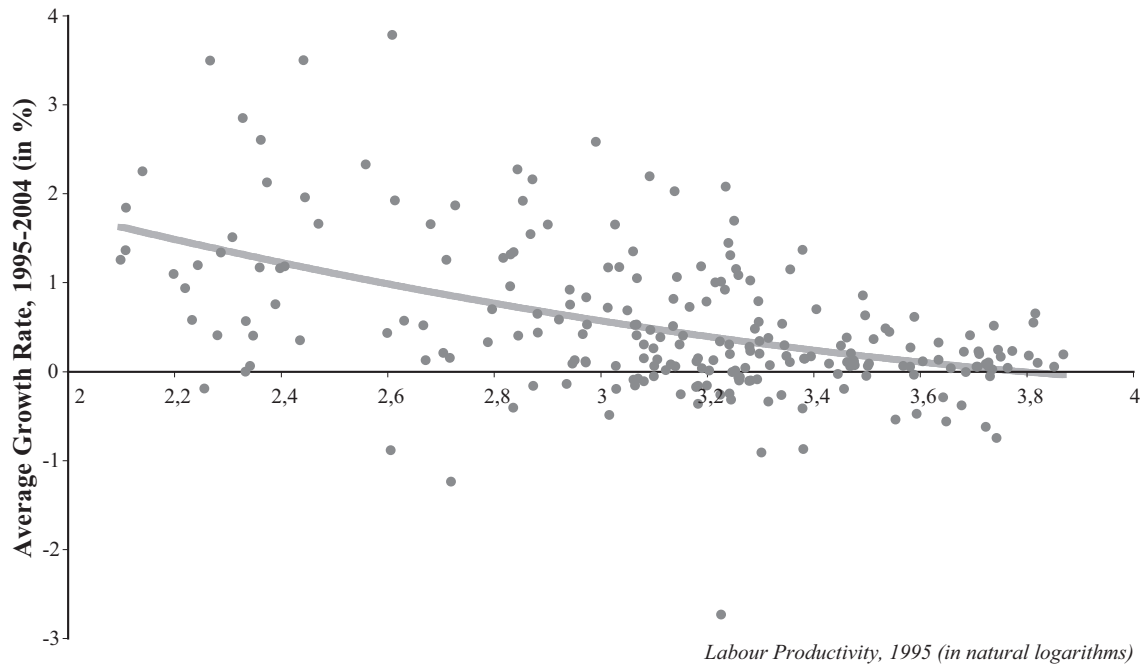
The *Akaike* and the *Schwartz-Bayesian* (hereafter *AIC* and *SBC*, respectively) information criteria have been used for the model selection. As a rule of thumb, the best fitting model is the one that yields the minimum values for the *AIC* or the *SBC* criterion, calculated as  $AIC = -2L + 2K$  and  $SBC = -2L + K \ln(T)$ , where  $L$  is the value of the log likelihood function,  $T$  is the number of observations and  $K$  stands for the number of parameters estimated<sup>6</sup>. According to the *AIC* criterion, equation (4) is superior from the other specifications, since the values of this criterion are minimized. This is also confirmed by the superior *SBC* criterion, which indicates that in all cases equation (4), explains the process of convergence in RALP to a more satisfactory degree.

The members of the convergence-club can be identified by calculating the threshold point ( $y^*$ ) at which  $\frac{\partial g_{i,T}}{y_{i,0}} < 0$ . According to the estimated value of  $y^*$  (about 9,000

Euros) this club includes 198 regions. It might be argued that these regions have reached a situation of steady-state equilibrium. These regions grow with less than 0.5% per annum while the average growth rate of all regions is 0.6%.

On the other hand, the excluded regions exhibit a rate of growth about 1% annually while their average level of initial productivity, in 1995, amounts to 5,300 Euros, less

than the average level of productivity in 1995 of all EU regions (17,000 Euros) and that of the convergence-club (23,000 Euros). Hence, it confirmed that the convergence-club includes relatively 'rich regions' (above-the-average) that exhibit relatively low rates of growth (below-the-average) while a reverse situation appears for the regions excluded from the club, i.e. 'poor' regions with initial level of productivity below the average and exhibiting a relatively higher growth rate (above-the-average).



**Figure 3:**  $\beta$ -convergence in the convergence-club

**Table 2.**  $\beta$ -convergence among club-members, 1995-2004

Depended Variable: $g_{iT}$ , OLS Sample: 198 EU-25 NUTS-2 Regions	
$a$	0.8036* (7.125)
$b_{cc}$	-0.2107* (-5.870)
Implied $\beta$	0.023* (5.270)

Notes: Figures in brackets are t-ratios. \* indicates statistical significance at 95% level of confidence.

Figure 3 clearly indicates absolute convergence *within* the convergence-club. Testing formally this hypothesis yields an average rate almost equal to the 'stylised-fact' of Sala-i-Marin (1996) of 2%, as shown in Table 2. On the other hand, this does not seem to be case for the excluded regions, as shown in Figure 4, which makes visible that regions with relatively high initial level of labour productivity also exhibit relatively higher rates of growth. This is confirmed by testing for absolute convergence using the regions excluded from the convergence-club. The estimated results in Table 3 imply that



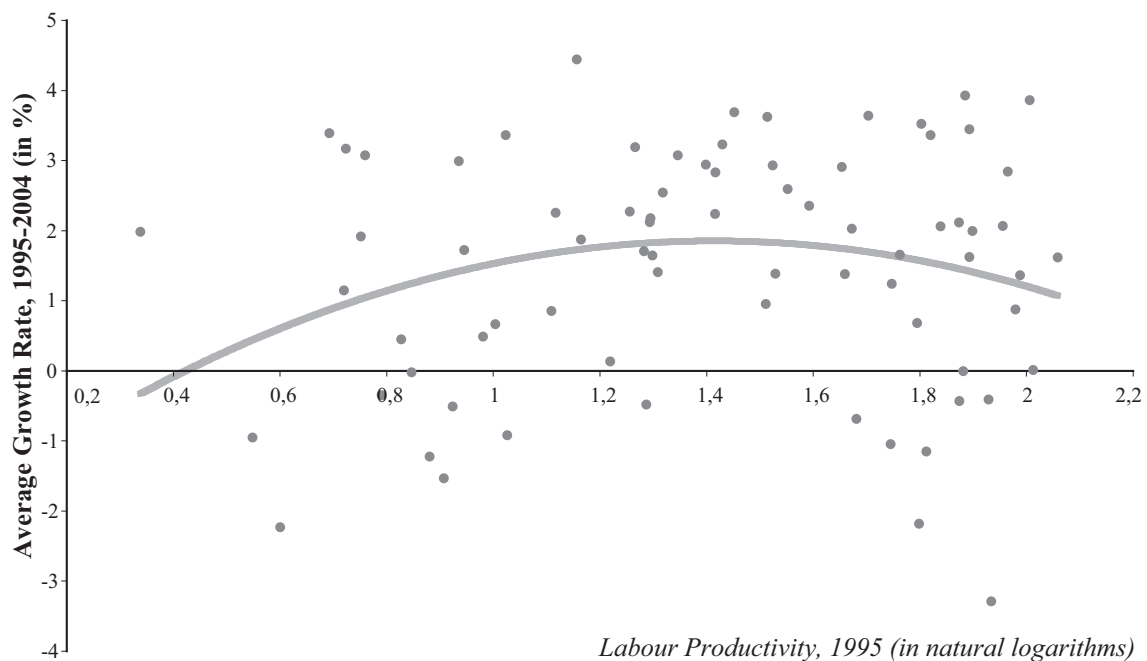
the regions excluded from the convergence-club actually *diverge* at a rate equal to 1.7% per annum.

Comparing the estimated rates of growth between the two groups it is clear that the regions in the convergence club grow faster compare to the regions excluded from the convergence club  $\beta_{cc} - \beta_{nc} > 0$ . This enhances the view that regional convergence in Europe is not uniform and follows a club pattern, at least in the case of the agricultural sector.

**Table 3:**  $\beta$ -convergence among non club-members, 1995-2004

Depended Variable: $g_{iT}$ , OLS	
Sample: 60 EU-25 NUTS-2 Regions	
$a$	-0.4213* (-0.813)
$b_{nc}$	0.1933* (4.085)
Implied $\beta$	0.017* (6.702)

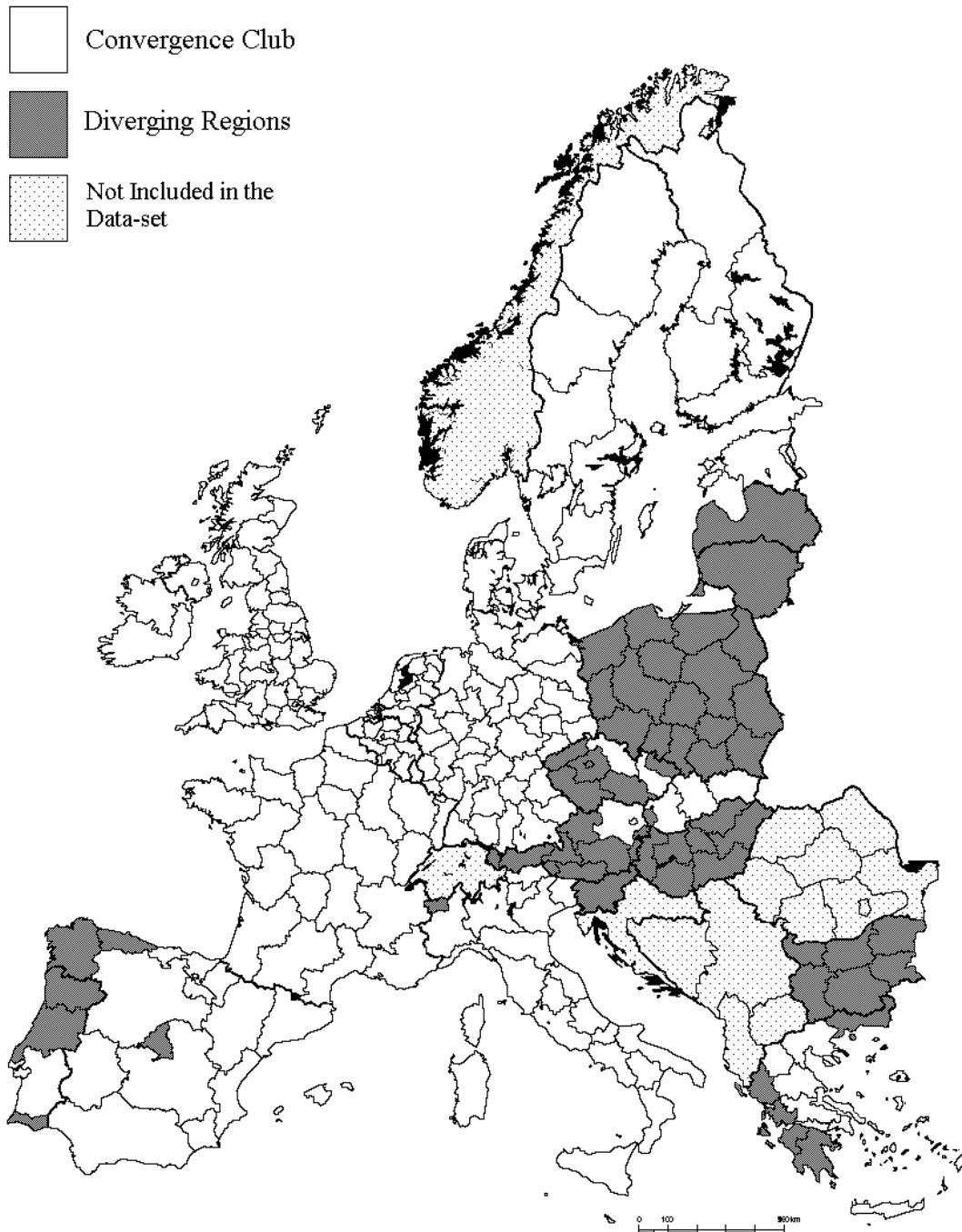
Notes: Figures in brackets are t-ratios. \* indicates statistical significance at 95% level of confidence.



**Figure 4:** Non-club members

The convergence-club includes, almost exclusively, regions from EU-12 countries. Fewer regions are included from EU-15 countries (about 7% of the convergence club) whilst only 3% of the club refers to regions from new and ascending countries-members, such as Slovakia and Czech Republic. The set of the non-converging regions includes, to a great extent (65% of the set), regions from new member-sates (e.g. Po-

land, Latvia, Lithuania, Bulgaria) and some regions from EU-12 Mediterranean countries (Greece, Spain and Portugal). The diverging regions are all located around the 'edge' of the EU, as shown in Figure 5.



**Figure 5:** Club Convergence in European Agriculture

### Conclusions and Policy Implications

In the case of the EU, and although an increasing number of empirical studies have

paid attention to issues of regional convergence; the empirical assessment of agricultural productivity convergence has not so far received the due attention. To remedy this, convergence in agricultural labour productivity is tested empirically using data for 258 NUTS-2 regions of the EU-26 over the period 1995-2004. The contribution of this paper's empirical findings is therefore not just limited to adding to the list of empirical tests on regional convergence successful tests, but most importantly from a policy point of view, providing the first evidence of club-convergence across the EU-26 regions.

Taken as a whole, we think that these results are important for the ongoing European policy debate about regional convergence. What is clarified by the econometric results is that the property of convergence is restricted to an exclusive convergence-club. From a policy perspective, this evidence is useful at two levels. Firstly, given a general focus at national and EU level upon support for lagging regions and the promotion of convergence, the identification of a convergence-club clearly assists in drawing a dividing line between regions which might be deemed eligible for assistance and those which are not. Regional assistance should, to a substantial extent, be diverted towards those regions that do not belong to the convergence-club. Secondly, the greater part of effort and assistance should be directed to improve the underlying conditions of lagging regions and thereby generate an economic environment that more closely resembles the combination of characteristics found in the convergence-club.

While the empirical results are serious in the own right, they must be placed in perspective. There is a little pretence that the forgoing analysis provides an exhaustive account of all the factors that affect the process of regional convergence in terms of agriculture productivity. For example, additional complications arise from the multidimensional nature of the institutional and political structure of the CAP; a factor that, indubitably, has important spatial implications. Considerably more research, therefore, is required before the issue of regional convergence in agricultural productivity can be discussed with confidence. What then is the purpose of this paper? Perhaps the main purpose of this paper should be to provoke interest in further work on the underlying mechanisms of convergence in regional agricultural labour productivity.

## Notes

- <sup>1</sup> Indeed, there appears to be a strong and extensive literature testing convergence in the EU, including Sala-i-Martin (1996), Boldrin and Canova (2001), etc. These studies refer to the economy as a whole whilst fewer studies have been conducted for specific sectors, usually manufacturing. See for example Pascual and Westermann (2002), Gugler and Pfaffermayr (2004).
- <sup>2</sup> This argument has been dealt with at length in Fennell (1997).
- <sup>3</sup> Some notable exemptions are the studies by Soares and Ronco (2000) for 14 EU member states, McCunn and Huffman (2000) and Ball *et al.* (2004) who apply cross-section tests across the USA states.
- <sup>4</sup> The error term is assumed have zero mean and constant variance, and to be independent and identically distributed over time and across the observational units and uncorrelated with the initial level of output per worker.
- <sup>5</sup> Barro (1991) provides further support for this conclusion by arguing that over a forty

year period (1950-1988) convergence is restricted to OECD countries. However, Canova (2004) suggests that even among the OECD countries convergence is not apparent, indicating a club convergence even within the economies of a convergence club identified by others. More specifically, Canova (2004) argues that the initially poor countries in the OECD diverge from the initially rich countries, and it is the latter which form the exclusive convergence club.

- <sup>6</sup> The SBS test has superior properties and is asymptotically consistent, whereas the AIC is biased towards selecting an overparameterized model.

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