Convergence in Agriculture: Evidence from the regions of an Enlarged EU

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I. Introduction

A major concern for economists is whether levels of labour productivity tend to converge or diverge over the long-run, and whether such trends apply to all or only limited groups of economies. This latter possibility, known as club-convergence, was originally introduced by Baumol (1986) in recognition of convergence within a subset of national economies. As Baumol and Wolff (1988, p. 1159) subsequently noted, however, '[…] just how countries achieve membership in the convergence club, and on what basis they are sometimes ejected' is a difficult question to answer.

This issue can also be tackled with respect to different areas within a country, that is to say, regions. In the context of *regional convergence*, the term 'region' refers either to areas determined according to similarities in geographical characteristics or areas corresponding to administrative divisions, which may be arbitrary.

As perhaps anticipated, recent years have witnessed a growing number of attempts to assess the extent of regional convergence in European Union (hereafter EU)[1]. Regional convergence is of interest, not only from a theoretical perspective but also from the point of view of economic policy. A more balanced distribution of income across the regions of a country promotes efficiency in the use of national resources, and social and political cohesion in that country.

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[1] See for example Button and Pentecost (1995), Neven and Gouyette (1995), Álvarez-Garcia *et al*. (2004), Ezcurra *et al*. (2005) among others. These refer to the regional economy as a whole while fewer studies conducted with explicit reference to specific sectors, usually the manufacturing (Pascual and Westermann, 2002; Gugler and Pfaffermayr, 2004) or the services sector (e.g. Button and Pentecost, 1993).

Cohesion is one of the primary targets in the context of the EU. Indeed, 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. Moreover, according to the third report of the European Commission (2004) on social cohesion, regional convergence or 'regional cohesion' is seen as vital to the success of several other key policy objectives, such as the single market, monetary union, EU competitiveness and enlargement.

The Treaty of Rome 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". Surprisingly, however, agriculture has received little attention. Convergence in terms of regional agricultural labour productivity (hereafter RALP) still remains a virtually unexploited mine of research for regional and agricultural economists[2].

An essential aim of this paper is to contribute to an understanding of convergence and specifically of club-convergence, using the regions of the EU as an empirical context. We should emphasise at the outset that the approach used in this paper is mainly quantitative. However, it is hoped that this paper will be able to isolate some interesting views on the issue of convergence in RALP across Europe.

Dived into four sections, this paper is organised as follows. The context, in which the paper's main question emerges, *viz*. the empirical approach to convergence, is discussed in Section II. The empirical assessment of regional convergence in the EU-25 is undertaken in Section III. Finally, in Section V the implications of the results for the debate concerning convergence across the EU countries are assessed and we argue that might afford an interesting policy conclusion.

[2] To our knowledge, only two studies refer to regional convergence in agriculture, namely Bivand and Branstad (2003; 2005).

II. Absolute and Club-convergence

Absolute or β-convergence is 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, or labour productivity, across economies. The first statistical test of this hypothesis is found in Baumol (1986), generally regarded as a major contribution to the convergence debate. Baumol (1986) identifies convergence 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,

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

where $y_{i,0}$ is the natural logarithm of output per-worker at some initial time for the ith region, a is the constant term, b is the convergence coefficient and ε_i is the random error term. If the growth of output per-worker ($Y_{i,T}$) is represented as $Y_{i,T} = e^{g_i} Y_{i,0}$, then taking logarithms and solving for g_i, the growth rate over a period of time (g_i) is represented by $g_i = y_{i,T} - y_{i,0}$, where T is a terminal time.

Convergence requires that $f'_{g_{i,T} y_{i,0}} < 0$. The intuition behind this argument is that regions with relatively low initial labour productivity grow faster that those with relatively high labour productivity, 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 zero 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 differences across regions. A distinction is made between the convergence coefficient b and the speed of convergence β. Following Barro and Sala-i-Martin (1995) the convergence coefficient b may be expressed as follows:

$$b = -\left(1 - e^{-\beta T}\right) \qquad (2)$$

where T is the number of years included in the period of analysis. The term for $\beta = -\dfrac{\ln(b+1)}{T}$ 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 β corresponds to more rapid convergence.

Estimating equation (1) using various data sets, Sala-i-Martin (1996) estimates a 'surprisingly' similar rate of convergence across both regional and national economies, and forms the 'mnemonic rule' that 'economies converge at a speed of about two percent per year.' (p. 1326).

In his seminal paper Baumol (1986) introduced an alternative concept of convergence, that of *club-convergence*. Recently, club-convergence is acknowledged as being a more probable outcome across regional economies[3]. Although different authors propose various methods of detecting club convergence[4], a test used extensively in empirical applications is provided by Baumol and Wolff (1988). According to Baumol and Wolff (1988), the standard test for absolute convergence is augmented by the introduction of a quadratic term to allow the possibilities of non-linearities in the convergence pattern. Thus,

$$g_{i,T} = a + b_1 y_{i,0} + b_2 y_{i,0}^2 \qquad (3)$$

This quadratic function is illustrated in Figure 1 and is drawn on the assumption that $b_1 > 0$ and $b_2 < 0$, which are the conditions required for the existence of a convergence-club. Growth reaches a maximum (g^*) when $f'_{g_{i,T} y_{i,0}} = 0$:

$$f'_{g_{i,T} y_{i,0}} = b_1 + 2b_2 (y_{i,0}) = 0 \qquad (4)$$

Solving equation (4) for $y_{i,0}$ yields a level of initial labour productivity which corresponds to maximum growth. Thus,

$$y^* = -\frac{b_1}{2b_2} \qquad (5)$$

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[3] See for example Canova (2004), Corrado *et al*. (2005), Fischer and Stirböck (2006), among others.

[4] See for example Chatterji (1992), Chatterji and Dewhurst (1994), Durlauf and Johnson (1995) among others.

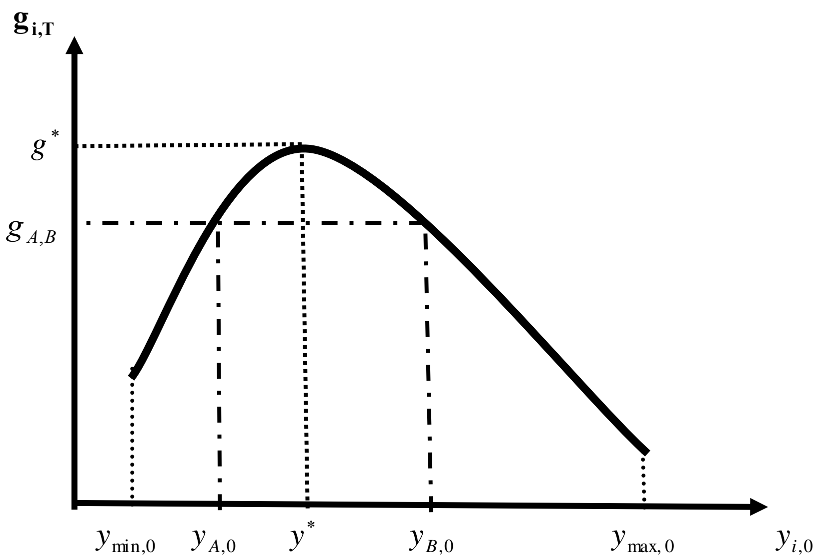

Figure 1: Club Convergence

It is this turning point which is used to identify members of the convergence-club. For regions with $y^* - y_{i,0} < 0$, growth is inversely related to the initial level of labour productivity ($f'_{g_{i,T}y_{i,0}} < 0 \; \forall i \in [y^*, \ldots, y_{max,0}]$). It may therefore be argued that these regions constitute a 'convergence club' by exhibiting β-convergence. The opposite holds for regions with $y^* - y_{i,0} > 0$. In this case, growth is positively related to initial labour productivity ($f'_{g_{i,T}y_{i,0}} > 0 \; \forall i \in [y_{min,0}, \ldots, y^*]$), 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 labour productivity, determine the composition of the convergence-club. Stated in alternative terms, a convergence-club is unlikely to consist of regions with markedly different levels of labour productivity; all must lie within a range that is equal to, or above, the *threshold* value y^*, i.e. $y_{i,0} - y^* \geq 0$.

The following example is illustrative. Consider two regions, A and B, each with an identical growth rate ($g_{A,T} = g_{B,T}$) with $y_{A,0} - y^* < 0$ 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 $(g_{A,T} - g_{B,T})_\tau = 0$, then $(y_A - y_B)_\tau < 0$ as $\tau \to \infty$, 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 $(g_{A,T} - g_{B,T})_\tau > 0$, as $\tau \to \infty$.

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 $f'_{g_{i,T} y_{i,0}} < 0$ 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. A relatively high (low) level of initial labour productivity, defined as $y^* - y_{i,0} < 0$ ($y^* - y_{i,0} > 0$), ensures β-convergence (divergence). This is consistent with Baumol's description of the convergence club as 'a very exclusive organisation' (p. 1079).

III. Empirical Application

Agricultural productivity can be approximated in several ways. In this paper we exploit data on GVA per worker 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) and Durlauf and Quah (1999) point out that convergence-regressions, such as equation (1), are valid for shorter time periods as well, since they are based on an approximation around the 'steady-state' and supposed to capture the dynamics toward the 'steady-state'.

The potential for β-convergence is indicated in Figure 2, which shows a scatterplot of the average annual growth rate against the initial level of labour productivity. 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.

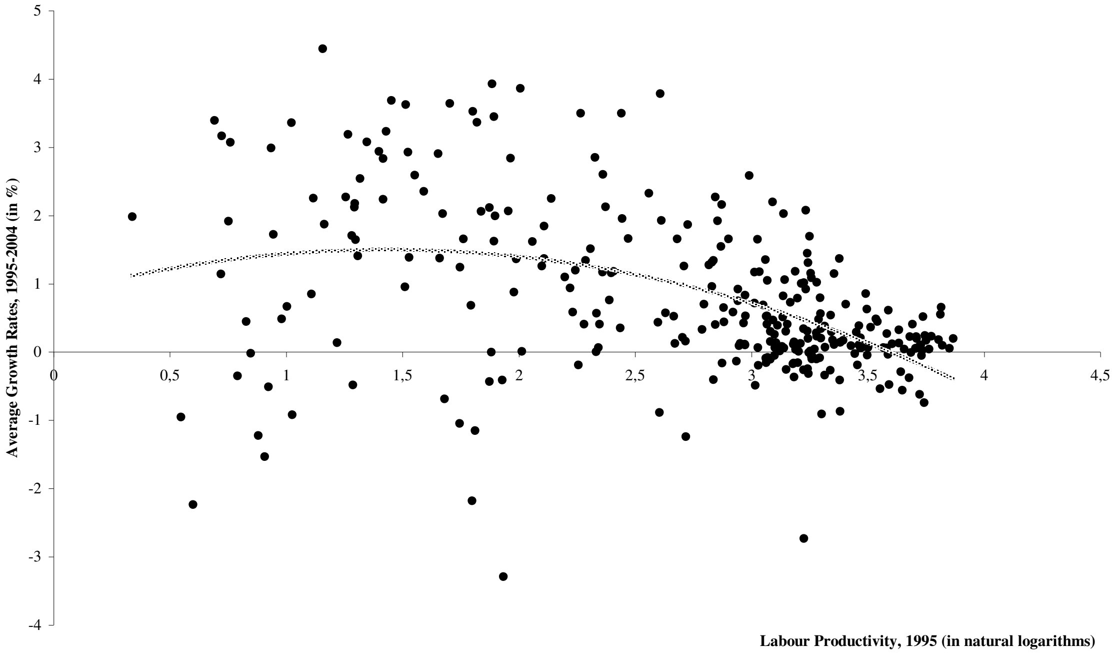

Figure 2: β-convergence, EU-25 regions, 1995-2004

As a first step in the process of assessing convergence in the EU-25 regions a test for absolute β-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. The members of the convergence-club can be identified by calculating the threshold point (y^*) at which $f'_{g_{i,T} y_{i,0}} < 0$. 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.

Table 1: Absolute and Club Convergence, 1995-2004

Depended Variable: g_i, OLS Sample: 258 EU-25 NUTS-2 Regions		
a	0.129** (4.959)	-0.310** (-2.416)
b_1	-0.050** (-2.443)	0.521** (4.761)
b_2		-0.118** (-5.307)
Implied β	0.0051** (2.381)	
Implied y^*		2.209** (23.937)

Notes: Figures in brackets are t-ratios. ** indicates statistical significance at 95% level of confidence while * indicates significance at 90% level.

The set of non-converging regions exhibits 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).

The regions in the convergence-club exhibit an inverse relation between growth and initial labour productivity. This is obvious in Figure 3, which 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 (1996a) 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.

Table 2: β-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 β	0.023* (5.270)

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

Table 3: β-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 β	0.017* (6.702)

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

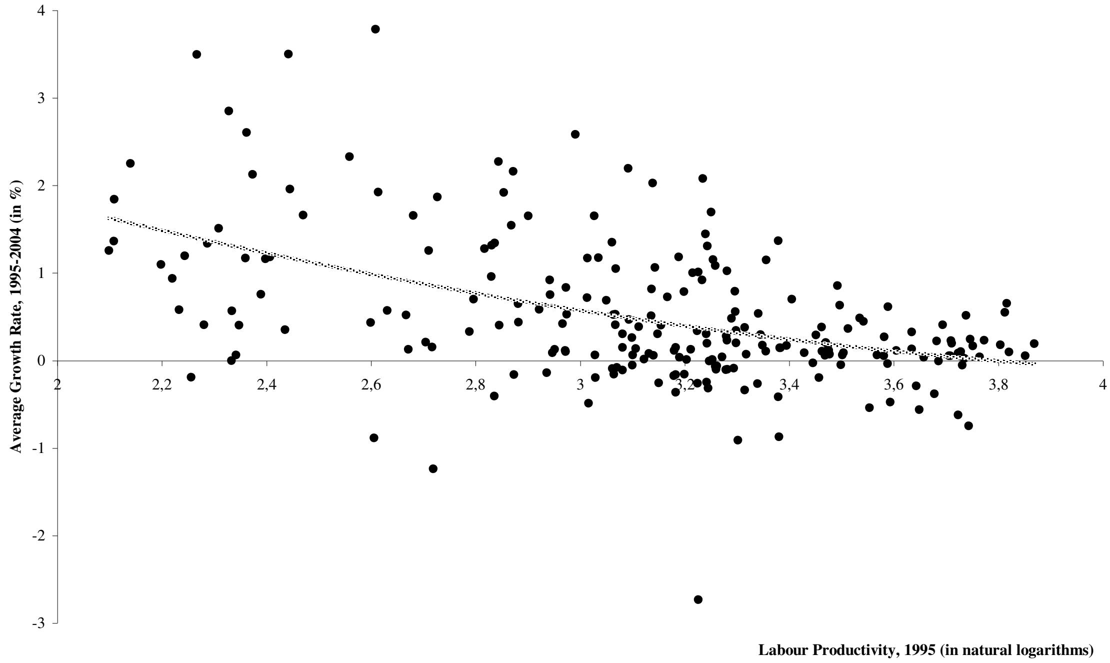

Figure 3: β-convergence in the convergence-club

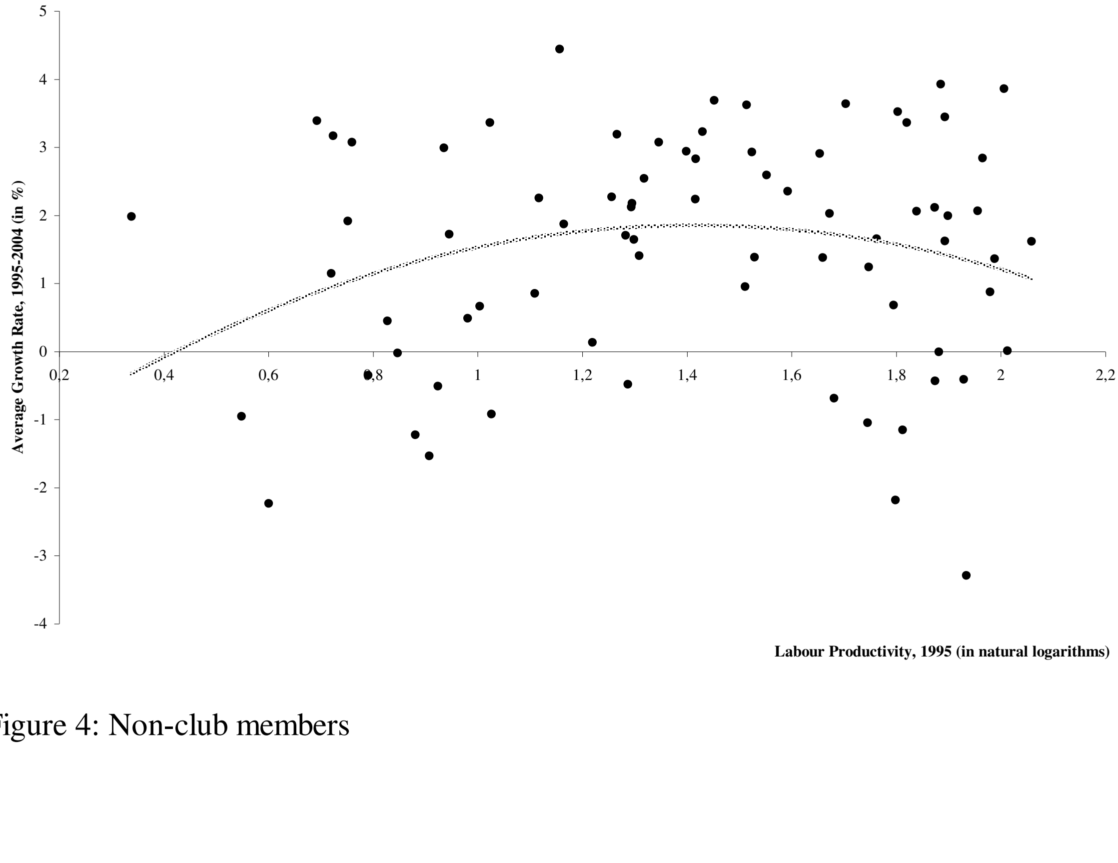

Figure 4: Non-club members

Testing for β-convergence for these two distinct regional groupings enhance the view that regional convergence in Europe is not uniform and follows a club pattern, at least in the case of the agricultural sector. Rates of convergence are expected to differ amongst these regional groups ($\beta_{cc} - \beta_{nc} \neq 0$). Indeed, 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, $\beta_{cc} - \beta_{nc} > 0$.

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 extend (65% of the set), regions from new member-sates (e.g. Poland, 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.

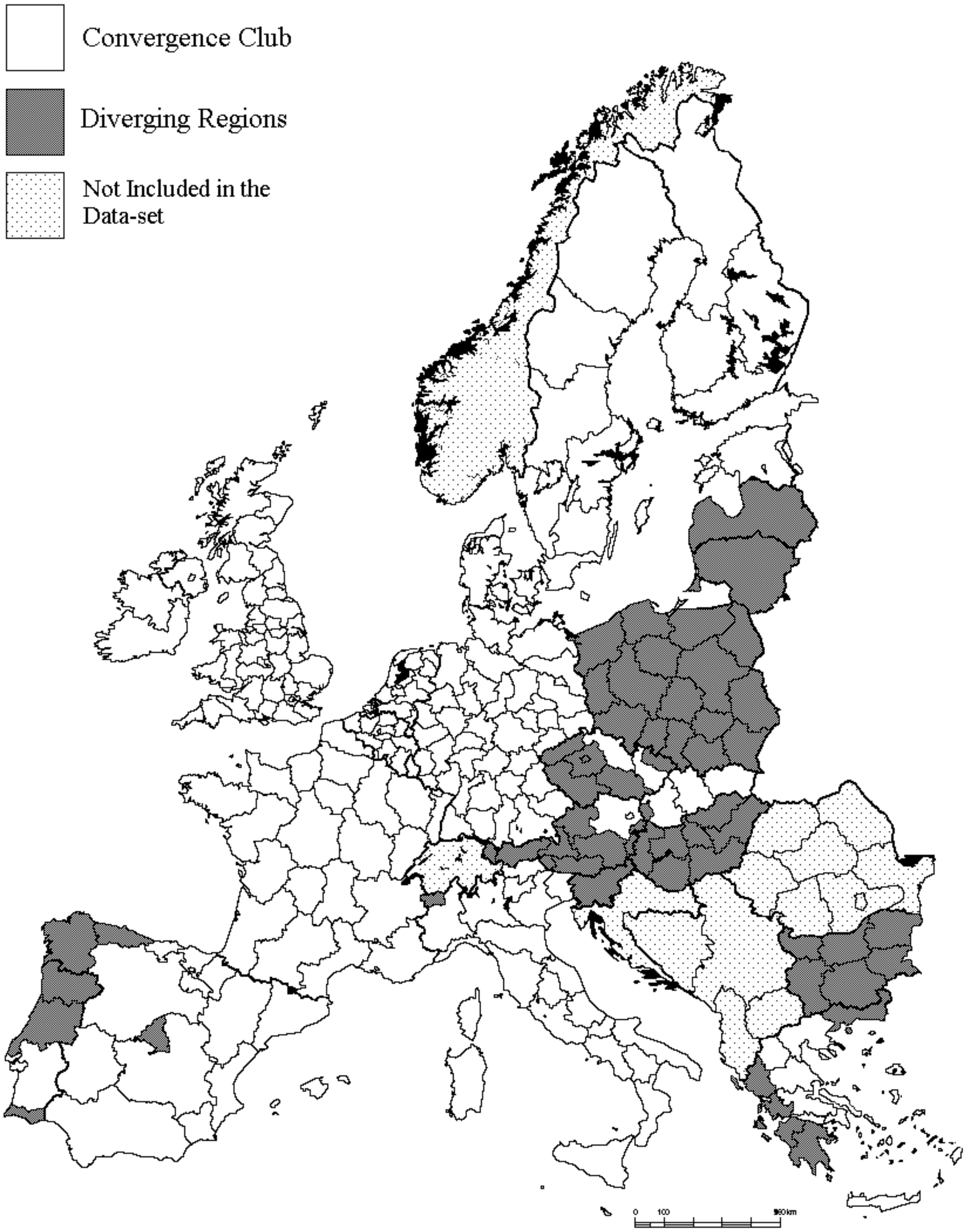

Figure 5: Club Convergence in European Agriculture

IV. 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-25 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-25 regions. More than ever, policy makers need independent and encompassing studies like this, which can provide critical new information about the specific pattern that prevails across the European 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 Common Agricultural Policy; 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.

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