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# Convergence in the Agricultural Incomes: a Comparison between the US and EU

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# **Convergence in the Agricultural Incomes: A Comparison between the US and EU**

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## **Abstract**

In this paper we compare the changes in farm incomes in EU regions and US States between 1989 and 2002. The aim of this comparative analysis is to highlight the patterns of convergence or divergence and how they differ over time. We use two recent analytical instruments: non-stationary panel analysis and dynamic distribution analysis. Both tools overcome the problems involved in using standard cross-section analysis. The results of the non-stationary panel analysis show that the EU regions are converging, and that family farm income is converging faster than net added value. In the US states the analysis shows that substantial differences in farm income persist, and there are no evident signs of convergence. While, the regions are heterogeneous, we modified the analysis to allow for the concept of conditional convergence. The results show that the regions converge towards different levels of productivity but regions that are further from their steady-state level will grow faster.

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## **1. Introduction**

In this paper we examine the changes in farm revenue at regional EU level and US State level for the period 1989 to 2002 in order to perform a comparative analysis of the pattern of convergence or persistence of differences and how these patterns change during the period. Convergence analysis is important because it leads to the question of whether the return level to which agricultural markets converge is sufficient to keep agriculture viable. The aim of the paper is to introduce new evidence on this topic.

During recent years the empirical literature on income convergence has evolved. The early studies were mainly based on cross-country analysis, which regresses the average per-capita income growth rates on the initial income level. Negative correlation between income growth and initial income is interpreted as evidence of the convergence hypothesis. The appropriateness of the cross-country regression method has been questioned by Quah (1993a), who shows that an inverse relationship between income growth and initial income is consistent with a stable variance in cross-country variance. In addition Bernard and Durlauf (1996) highlighted that cross-section tests tend to spuriously reject the null of convergence when countries have different long-run steady states, or in other words, transition matters in determining income dynamics.

Two different methodologies have been employed to solve the previous problems. The first procedure was proposed and applied in a number of papers by Quah (1993b, 1996) and Brasili (2005), who studied the entire distribution to assess cross-country convergence of per-capita incomes. These studies usually show that “twin peaks” or convergence clubs are formed, i.e. the income distribution polarises into “peaks” or “clubs” of rich and poor countries. The second methodology uses panel unit root tests to evaluate per-capita income convergence. These are more suitable for taking into account income heterogeneity across countries or regions and over time.

Because financial support to agriculture heavily influences the level of farm income and its dynamics, in the following section we will start the analysis by presenting the recent changes in the

agricultural policies of the EU and USA. The main emphasis will be on the differences and similarities in these changes. In section 2 we introduce the dataset and in section 3 and section 4 we analyse the convergence process using panel time series analysis in section 3 and the stochastic kernel in section 4. Section 5 is the conclusions.

## **2. Recent trends in the agricultural policies of the US and EU.**

The chronic surplus situation of agriculture in USA (from the 1970's) and in EU (from the 1980's) was combined with a high level of support to farmers. Price and revenue support to farmers were the main types of public financial intervention in agriculture, but their relative importance has changed over the years because of reforms in agricultural policy.

US reform of agricultural policy started earlier, in 1973, with the reduction in the old price support mechanism. The price support scheme was substituted with deficiency payments to farmers, requirement of uncompensated set-aside and a safety net to allow for the market prices dropping below the loan rate. The EU started to discuss reform of agricultural policy later, at the beginning of the eighties, as the result of severe budget crises. The EU reform process was not linear. At first they tried to impose quantitative limits on production (quotas for milk in 1984, maximum guaranteed quantities for cereals and oilseeds in 1988) and only in 1992 did the EU change the old price support system.

The changes and reform in UE and USA farm policies was particularly relevant during the 1990's. The changes were the result of both internal and international pressure (budgetary pressure and Uruguay round negotiations). The McSharry reform of the Common Agricultural Policy in 1992 and the FAIR Act reform of US policy in 1995 were the greatest changes made in the 1990's. The FAIR Act of 1996 further emphasised the move towards market-oriented strategies in US farm policy. The de-coupling of payments from production was more widely used in US agriculture. The deficient payment system was eliminated as were target prices and the limits on set-aside programs. The farmers where compensated for the latter with payments based on acreages and past crop yields

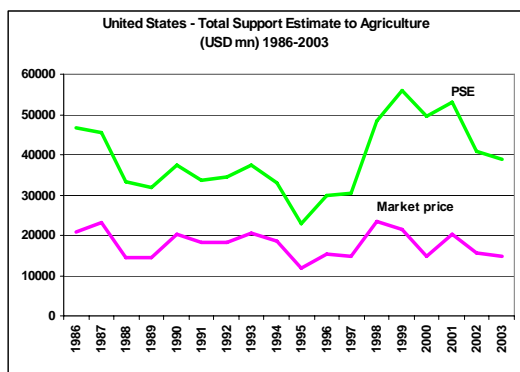
(production flexibility contract). The FAIR Act of 1996 established a specific Fund for Rural America as part of US agricultural policy. As a consequence of the FAIR Act, the total amount of financial support to agriculture increased. The EU reform of agricultural policy in 1992 sharply reduced the support price for cereals and oil seeds. To compensate the farmers for the losses, a payment was introduced based on number of hectares and past yields, calculated differently for each crop. This reform was not de-coupled because the payments were calculated for each crop, using the historical yields at regional and sub-regional level. The reform was applied gradually during a three year period, and the total financial support to agriculture increased slowly.

The almost complete de-coupling scheme of payments was only fully introduced in the EU with the Mid Term Review of Common Agricultural policies in 2003 (Haniotis 2002). In the same period, in 2002, a new Farm Bill was introduced in the USA. This reversed many of the FAIR Acts policies, reintroducing, for example, the target price system and a new “counter-cyclical payment”, which provided “emergency payments” in cases where the market price fell (Wescott, Yong and Prices, 2002, USDA 2003). These important changes in the EU and US agricultural policies were accompanied by more emphasis on the environment and on support for rural development. Environmental support was introduced by the McSharry reforms of 1992, and new specific regional rural development plans were supported by the reform of the structural Funds in 1998. In Agenda 2000 the EU policy reforms stressed the role of multi-functionality in rural development. These new policies are of increasing relevance to the structure of EU agriculture, where there are still a great number of farms (more than 6.7 million in 2002 in the EU-15) and farm workers (about 6.7 million) and great regional disparities in agricultural revenue. In the US agriculture is characterised by large farms and fewer farm workers (about 2.1 million farms and 3.4 million farm workers).

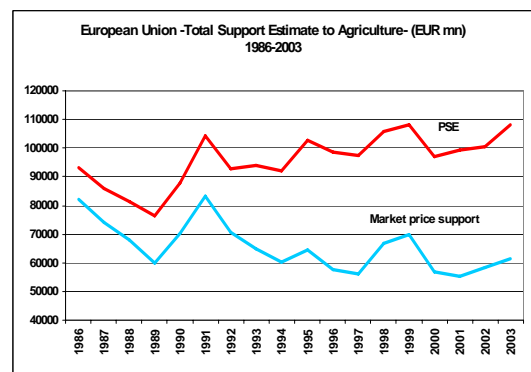
The OECD data base (OECD 2005) on the agricultural national Production Support Estimate (PSE) shows the changes in the UE and US farm policies and their financial support from 1985 to 2003. The dynamics of US total PSE changed between 1985 and 2003. There was a steady

reduction from \$47 billion in 1986 to \$25 billion in 1995. There was then a sharp consistent rise after the FAIR Act of 1996, and PSE rose to \$52 billion in 2000-2001. Finally after 2001, there was a sharp decrease, with the figure falling to less than \$40 billion in 2003. EU total PSE is much higher than that of the US, and grew linearly from about €90 billion in 1986 to more than €100 billion in 2003. In the same period, this rise was accompanied by a clear decrease in market price support in the EU.

The agricultural policies in both continents are still different, as can be seen from the differences in the total financial support to the agriculture sector. There are great differences in domestic support for agriculture, depending of the commodity (Moyer, Josling, 2002), and also on the different types of farms and their size (USDA, 2003).



Source: OECD 2005



Source: OECD 2005

## 2. The Data Set

In order to see if the agricultural policies in the two continents have contributed to convergence of farm incomes in the EU and in the US, it is useful to compare the dynamics of agricultural income looking at two key indicators derived from different data sets for the period 1989 to 2002.

The European Union Data used here come from FADN database (Eurostat) for 85 regions (listed in Appendix, Table 1A). The first indicator is the Farm Net Value Added (FNVA) divided by

the Total Utilised Agricultural Area (TUAA) in the years from 1989 to 2002. The second indicator uses the Family Farm Income (FFI) divided by TUAA<sup>1</sup>.

The above mentioned indicators are extremely variable due to the different characteristics of farms in the 85 EU regions. They vary in size from the Liguria and Hamburg regions with average farm sizes of little more than 3 hectares (7.41 acres) to Scotland, with an average farm size of more than 305 hectares (753 acres). Thus, when computing the two ratios FNVA/TUAA and FFI/TUAA, we note that Liguria and Hamburg have the highest value, while Scotland has the lowest, with a ratio eighty times less than Liguria and Hamburg.

For the US we use two income indicators, the Net Value Added and the Net Cash Income. As is well known, the Net Cash Income measures the funds that are available to farm operators to meet family living expenses and make debt payments. In family owned businesses, these are not separate decisions. We assume that this variable, although it differs from the EU Family Farm Income definition, satisfactorily reflects the changing economic situation of US farming.

### 3. Panel analysis

In order to analyze the panel unit root approach to convergence let us start by introducing the following dynamic panel regression equation

$$\ln\left(\frac{y_{it}}{y_{t..}}\right) = \rho_i \ln\left(\frac{y_{it-1}}{y_{t-1..}}\right) + \sum_{s=1}^p \beta_{is} (1-L) \ln\left(\frac{y_{it-s}}{y_{t-s..}}\right) + u_{it} \quad (1)$$

where  $y_{it}$  is the observed income indicator per unit of land for region or state  $i$  at time  $t$ ,

$y_{t..} = \sum_{i=1}^N y_{t,i}$  is the cross-section average in each period  $t$ ,  $\alpha_i, \rho_i, \beta_{ij}$  are parameters,  $L$  is the lag

operator and  $u_{it}$  is a cross-sectional correlated error.<sup>2</sup> Looking at (1) one can easily infer that when

$\rho_i = 1$  for all  $i$ , all regions or state diverge, thus not rejecting the null hypothesis of a common panel

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<sup>1</sup> For a definition of these variables, see the Appendix B.

<sup>2</sup> Regression (1) has been studied by Evans (1998). Bernard and Durlauf (1995) examined a similar regression where the cross-section average  $y_{t..}$  was substituted by the per-capita income of a reference country  $j$ .



unit root is the same as accepting the hypothesis that during the period of analysis all regions do not converge to the cross section average. The alternative hypothesis is usually stated as  $H_1 : \rho_i < 1$ , at least for one region.

Looking at (1) it is simple to see that we are implicitly testing the hypothesis of convergence toward a common trend. The literature has called this hypothesis absolute convergence hypothesis (see Gutierrez, 2000). Absolute convergence is more likely to occur where regions have roughly similar preferences, technology levels and institutional and legal systems. If this is the case, regions converge to the same common trend. If regions are heterogeneous, the analysis must be modified to allow for the concept of conditional convergence. The central idea is that regions converge towards different levels of productivity but regions that are further from their steady-state level will grow faster. The hypothesis of conditional convergence can be easily inferred as

$$\ln\left(\frac{y_{it}}{y_{i.}}\right) = \rho_i \ln\left(\frac{y_{it-1}}{y_{i.}}\right) + \sum_{s=1}^n \beta_{is} (1-L) \ln\left(\frac{y_{it-s}}{y_{i.}}\right) + u_{it} \quad (2)$$

where now the convergence process is analyzed looking at the differences between the income indicator in each region and the regional temporal average  $y_{i.} = \sum_{t=1}^T y_{t,i}$ .

Before introducing results it is useful to answer the following questions. Why do we focalize the attention on panel regression and not on time series regression and why do we introduce a degree of cross-sectional dependence in (1)?

Over the last few years, a great deal of attention has been paid to the non-stationary property of panels. Starting from the seminal works of Quah (1990, 1994), Breitung and Meyer (1991) Levin and Lin (1992, 1993), and Im *et al.* (1997), many tests have been proposed which attempt to introduce unit root tests in panel data. These show that, by combining the time series information with that of the cross-section, the inference that unit roots exist can be more straightforward and precise, especially when the time series dimension of the data is relatively short, and similar data

may be obtained across a cross-section of units such as countries or commodities. In synthesis, panel unit root tests have higher power than time series unit root tests.

However all the panel unit root tests suffer from serious limitations when the cross-sectional units are correlated (see O’Connell, 1998). Some papers have been presented in recent years that address this issue. For example, Bai and Ng (2003), Moon and Perron (2003) and Phillips and Sul (2003a) and Choi (2002) use common factor components. In brief, all the above mentioned works propose a factor model in which cross-sectional dependence is generated by one or more factors<sup>3</sup> which are common to all the individual units (but which may exert different effects on the individual unit) and by uncorrelated idiosyncratic shocks across all the individual units.

The cross-sectional dependence is modelled as

$$u_{it} = \lambda_i' f_t + e_{it} \quad (2)$$

where  $f_t$  are  $K$  vectors of unobservable factors,  $\lambda_i'$  factor loading coefficient vectors and  $e_{it}$  are idiosyncratic shocks. Note that the panel unit root tests proposed by Levin and Lee (1992, 1993) and Im and al. (1997) fail to take account of cross-sectional dependence, causing on one hand huge size distortion of the tests and, on the other, introducing restrictive economic specification when, as seems to be the case especially for EU and US, incomes per unit of land show strong cross-sectional correlation.

The first task, when computing multifactor analysis as in (1), is to specify the number of factors  $r$  correctly. We follow Bai and Ng (2002) and we use what they label  $BIC_3$ . These criteria defines the correct number of factors, taking into account the mean squared sum of residuals, plus a penalty function for over-fitting. Bai and Ng (2002) show that these criteria perform well for our size of data sample. We compute the number of factors using a maximum of 5. The  $BIC_3$  criteria suggest that there are from two to three common factors.

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<sup>3</sup> This is not true for the Phillips and Sul (2003) tests where only one factor is permitted.

Before using panel unit root tests it is useful to analyze their size and power for our sample of data. We perform a Monte Carlo analysis, as in Gutierrez (2006), for a panel of 14 observations and 85 units. The results of the simulation, not reported for brevity, highlight that Moon and Perron's (2004)  $t_b$  statistic has correct size and high power. Choi (2002) tests are strongly oversized while Bai and Ng (2004) and Phillips and Sul (2003) tests are downsized with low power.

Given the better properties of Moon and Perron's (2004)  $t_b$  test, only this statistic is reported in Table 1. Looking at the results, the statistic rejects the null of non-stationarity only for EU when the full sample of regions and states are analysed, i.e. the test statistic rejects the hypothesis of absolute divergence across the EU regions, but not across the USA states during the period of analysis. Naturally this does not mean that all regions converge or diverge, indeed some may actually diverge and some converge. To analyse this, we split the sample into Objective 1 and non-Objective 1 regions for the EU and basically into North (excluding Alaska) and South plus Pacific States (excluding Hawaii) for the USA. Interestingly, we note that the  $t_b$  test statistic always rejects the null, indicating that agricultural incomes in the two samples of EU regions converge toward the EU average. The results are valid both for the net value added indicator and for the family farm income indicator. Similar results have recently been found by Brasili and Gutierrez (2004) when analysing convergence of per capita income for a sample of 140 NUTS2 EU regions during the period 1980-1999. By contrast, neither of the two US aggregates seem to converge during the period under analysis. In table 1 we also report the half-life a unit shock statistic. It is computed as  $\ln(0.5)/\ln(\hat{\rho})$ , where  $\hat{\rho}$  is the pooled rho estimate. Interestingly, while the half-life statistic for the EU net added value is approximately equal to 38 years, and similar values have been usually reported in convergence analysis, the family income indicator has lower values, on average not above 18 years. When we look at the set of regions included in Objective 1 more closely, we find that this variable has a shorter period of adjustment after a shock compared to net added value.

The picture for the US states is clearly different. Because we do not reject the null hypothesis of unit root we conclude that during the period of analysis US states do not show convergence.

**Table 1 - Panel Unit Root Tests EU and US Indicators (1989-2002) : absolute convergence**

<b>Group : EU regions</b>	Moon and Perron (2004) <b>t_b test (*)</b>	Rho coeff.	<b>Half-life shock</b> (n° years)	<b>Group : US States</b>	Moon and Perron (2004) <b>t_b test (*)</b>	Rho coeff.	<b>Half-life shock</b> (n° years)
Net Value Added per Unit of Land	-1.825(0.034)	0.970	31.8	Net Value Added per Unit of Land	-0.958(0.169)	0.995	194.8
Family Farm Income per Unit of Land	-3.979(0.000)	0.947	17.7	Net Cash Income for Unit of Land	-1.204(0.114)	0.989	87.3
<b>Objective 1 Regions</b>				<b>Northeast, Lake States, Corn Belt, Northern Plains, Appalachian</b>			
Net Value Added per Unit of Land	-1.980(0.023)	0.974	38.1	Net Value Added per Unit of Land	0.376 (0.647)	1.003	Neg.
Family Farm Income per Unit of Land	-5.598(0.000)	0.944	17.0	Family Farm Income per Unit of Land	-0.813 (0.208)	0.992	123.9
<b>Non Objective 1 Regions</b>				<b>Southeast, Delta States, Southern Plains, Mountains States, Pacific States</b>			
Net Value Added per Unit of Land	-2.413(0.007)	0.972	35.0	Net Value Added per Unit of Land	-1.477(0.070)	0.981	51.53
Family Farm Income per Unit of Land	-3.062(0.001)	0.954	21.1	Family Farm Income per Unit of Land	-0.964(0.164)	0.991	105.7

(\*) In parentheses p-values

In table 2 we report the results when testing for conditional convergence. Interestingly the convergence process is now faster. After a shock 50% is absorbed in approximately one year for EU and less than one year for the USA. Thus while regions seem to converge slowly toward a common trend process they seems to recover rapidly toward their steady-state productivity level after a shock.

**Table 2 - Panel Unit Root Tests EU and US Indicators (1989-2002): conditional convergence**

<b>Group : EU regions</b>	Moon and Perron (2004) <b>t_b test (*)</b>	Rho coeff.	<b>Half-life shock</b> (n° years)	<b>Group : US States</b>	Moon and Perron (2004) <b>t_b test (*)</b>	Rho coeff.	<b>Half-life shock</b> (n° years)
Net Value Added per Unit of Land	-16.560(0.00)	0.589	1.31	Net Value Added per Unit of Land	-8.673(0.000)	0.346	0.653
Family Farm Income per Unit of Land	-7.953(0.000)	0.561	1.19	Net Cash Income for Unit of Land	-19.180(0.000)	0.049	0.230

(\*) In parentheses p-values

We do not report values for the Objective 1 and geographic USA areas because they are quite similar to the aggregate values.

#### 4. Distribution Dynamics

We used the stochastic kernel method to analyse how the dynamics of distribution of the farm income indicators have changed between 1989 and 2002. This method of analysis makes it possible to highlight the differential dynamic patterns of the groups of EU regions and the set of US states.

The stochastic kernel method has been presented in a great number of papers (see for example Quah, 1993a, 1993b, 1996, 1997; Brasili 2005). Here will give only a brief outline, leaving the interested reader to refer to the above cited works for a deeper analysis.

Assuming that the agricultural income  $y_t$  can take values inside a certain finite set E, the distribution of that variable at time  $t$  (labeled  $F_t$ ), is time-invariant.  $\phi_t$  defines the associated probability measures of  $F_t$ . The dynamics of  $\phi_t$  can be modeled as a first order autoregressive

process:  $\phi_t = M' \phi_{t-1}, t \geq 1$  (3)

When  $y_t$  is discrete, the matrix  $M$  is usually defined as the transition probability of a Markov process, i.e. each element in  $M$  describes the probability of transition from a given state to another state in one step. However if  $y_t$  can take infinite values, i.e E is an uncountable set, we need a continuous counterpart of  $M$ . Let A be a subset of E and define a new function  $P(y, A)$ , called the stochastic transition function or stochastic kernel. This function describes the conditioned probability that in the next period the agricultural income will have a value in set A, given that in the previous period it is in the state  $y$ , i.e  $P(y, A) = \Pr(y_t \in A | y_{t-1} = y)$ .

Thus the income distributions in the two periods will be linked by the following relationship

$$F_t = \int P(y, A) F_{t-1} dy \quad (4)$$

In this section of the paper we will present an estimate of  $P(y, A)$  for the variables Farm Net Value Added (FNVA) divided by Total Utilised Agricultural Area (TUAA) for the European regions and the variables Net Value Added per unit of land and Net Cash Income per unit of land for the US

states. We analyse how the distribution of the farm income indicators has changed over time. The method allows us to establish whether the distributions around the EU and the US states average are now more concentrated or not than they were a decade ago. The analysis also allows to be better understood the results obtained in section 3.

As we have seen in the introduction, in the 1990's there were great changes in agricultural policy in both the EU (with the McSharry reform in 1992) and the US (with the 1990 Farm Bill and the 1996 FAIR Act). The EU 1992 reform substantially maintains the coupling of compensatory payments and production, while the 1990-96 US reforms decoupled more extensively. Our work allows, at least indirectly, to make inference on the impact of the two different policies on farm income distribution.

The stochastic kernel applied to the ratio of FNVA per TUAAs<sup>4</sup> relative to the average (located on the 0) of the EU 85 regions shows that there are two main groups of regions (figure 1). The literature on distribution dynamics has called this "twin-peaks" distribution. It was first described by Quah (1996) when he was analysing the convergence of per capita GDP for EU countries.

We found that, for FNVA per TUAAs, a very large group of EU regions are located in a range which is approximately from 0.25 to 3 times of the average value. The curve has the shape of a "saddle". The first mass point of the distribution is mainly located on the diagonal. This group has a very gentle rotation, and so there is a convergence towards the average value. Another smaller set of regions are around the second peak and located well above the average, more than eight times the average value of the variable. The second main mass of the distribution is also concentrated on the diagonal. Thus we have more persistence for the group of regions with higher values of FNVA per TUAAs. There is another small group of regions in the final part of distribution with very low revenues (around 10% of the average revenue). This group rotates anti-clockwise and converges

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towards the average value. The picture of distribution of the peaks can be better appreciated by looking at the contour plot (figure 1a)<sup>5</sup>.

The analysis of similar variables for the US states found a three peaks distributions. The first two peaks were both concentrated on the diagonal, with a strong persistence over time (figures 3 and 3a). The first peak had values of 25% the average value, while the second peak, which included a large number of States, was concentrated around the average. The third peak, with about three times the average value US net value added per hectare (about), clearly rotated anticlockwise, and thus converged. Thus in the 1990's the changes in US agricultural policies produced neither convergence nor great differences in the distribution of income in the two groups of States which had average or lower net added value per hectare. Convergence was only found in the States with the highest value for the variable.

The stochastic kernel applied to the variable FFI per TUAA<sup>6</sup> for the average value of the EU 85 regions, also showed two main regional peaks (figure 2 and 2a). The first group of regions (saddle distribution) is higher and wider with a range which varied from about 0.2 to 3 times of the average value. The greater part of this peak ( the regions with lower revenue) rotated anticlockwise towards the average. The second peak was about eight times the average value and was on the diagonal, but it rotated anti-clockwise. The regions with higher FFI/TUAA values showed the beginning of convergence in the EU regions. The over all analysis of family farm income showed that there was a clearer process of convergence than that found for the FNVA per TUAA. These results agree with that described in the previous paragraph.

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<sup>5</sup> The contour plot works in the exactly the same way as on a standard geographical map. Lines on the contour plot connect points at the same height on the three-dimensional stochastic kernel. A straight line is drawn in the contour plot to mark the diagonal, where all mass would be centred if there was complete persistence in the distribution, a mass parallel to the vertical axis shows a convergence process, a mass parallel to the horizontal axis shows divergence process. Moreover, in this analysis we have used the logarithms of the ratio to reduce the variability so we have to read the results consequently in the graph, our average correspond to zero.

<sup>6</sup> We compute the logarithms of the ratio in order to control the high variability of the series.

When stochastic kernel analysis was applied to variable Net Cash Income per unit of land for the US countries there were three main peaks. There was also a fourth peak with very low values of the variable, but it was not relevant, and so will not be discussed here (see figures 4 and 4a). The first two peaks were concentrated on the diagonal as were those of the previous analysis on Net Value Added per unit of land. The third peak, with the about three times the average value of Net Cash Income, was mainly located above the diagonal and clearly rotated anti-clockwise. This indicates the beginning of convergence among the group of States with the highest revenue.

In conclusion, dynamic distribution analysis shows that in the EU regions there are is general convergence, and this is more marked for the set of regions with a lower farm income per unit of land. The US States show strong persistency in each peak, with a large number of the States belonging to the group with incomes around the average farm income value. The only exception is for the group of States with higher farm income values. These converge. It would be interesting to analyse earlier periods in the USA (before 1989) to ascertain whether or not convergence had already occurred.

## **5. Conclusions**

Using a panel of EU and USA regions observed during the period 1989 to 2002 we investigate the absolute and conditional convergence hypothesis using both net value added and family farm income variables. Absolute convergence seems to be more likely to occur where regions have roughly similar preferences, technology levels and institutional and legal systems. If this is the case, regions converge to the same common trend. If regions are heterogeneous, the analysis must be modified to allow for the concept of conditional convergence. The central idea is that regions converge towards different levels of productivity but regions that are further from their steady-state level will grow faster.



The results show that the EU regions show absolute convergence, and the convergence process seems to be greater for the family farm income variable than for the net value added per hectare variable. By contrast US states show a substantial persistence of the differences in farm income, with no evident signs of absolute convergence. In the EU regions the convergence of farm income per hectare is greater for the less developed regions (objective 1 regions), whereas in the US there are no substantial differences between Northern and Southern states. Interestingly these results are partially reverted when analysis the conditional convergence. In this case both EU and the USA show a strong convergence process toward their productivity steady-state level.

Income distribution analysis shows that there is a “multi peak” distribution of farm incomes in both EU and US, but with great differences. In the EU regions there is a large group of regions with very low farm incomes and, on the other hand, another group of regions with very high income per hectare, at more than eight times the EU average. Between these two peaks there are numerous regions along the diagonal. This creates a sort of “saddle” distribution which is characteristic of the EU regions. The first group of regions is larger and shows convergence, particularly when Family Farm Income rather than Net Added Value is measured, and this could explain the convergence found by the panel analysis.

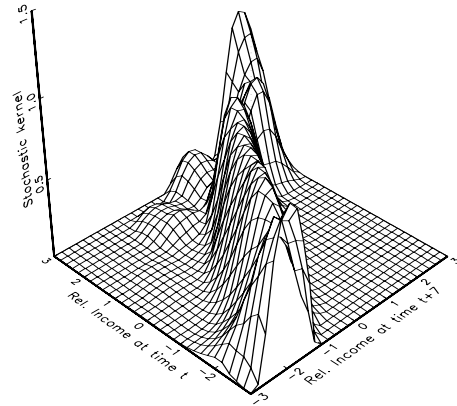
In the USA we found a “three peak” distribution characterized by the presence of a great number of states with farm incomes around the US average, and the other two groups of states far from the average value (i.e. much higher or lower). Thus in the USA convergence is not evident, and differences between states persist over time. Convergence towards the average value for farm income probably occurred in the previous decades, and the time horizon of our analysis (1989-2002) is not long enough capture these changes.

The distribution of farm income per hectare during the period 1989 to 1992 in the EU and US shows, in general, more persistence over time. There were also important changes in the domestic support given to agriculture. The already high level of domestic support in EU agriculture increased

during the 1990's, with a price support scheme being replaced by a direct farmers' income support scheme. This essentially coupled payments to farm production. In the US support for agriculture first declined sharply until 1995 and then increased until 2001, with a marked increase in de-coupling of payment and production. Only with the FARM Bill of 2002 was the tendency towards a de-coupling policy reversed. If we assume that the above-mentioned policies are able to influence farm income distribution, it seems that only the EU policies influenced this distribution, with some convergence occurring during the period 1989-2002. In the US income distribution appears unaffected and determined mainly by long term structural differences. Moreover, some preliminary analysis of US farm incomes over a longer period, i.e. 1950-2002 seems to confirm the persistence in the revenue distribution and it does not show great changes. We were unable to compare EU data for the same period because of lack of data. Further research is needed to estimate the relative importance of the agricultural policies in the EU and the USA on the distribution of farm income over time.

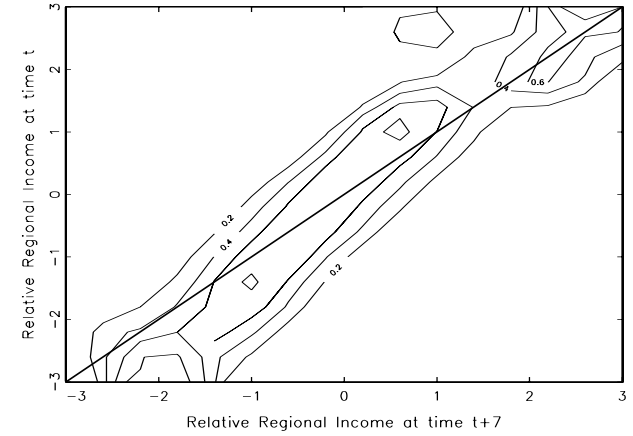
**Figure 1.a Stochastic Kernel EU Net Value Added per ha**

Stochastic kernel EU Net Value Added per hectares : 1989-2002



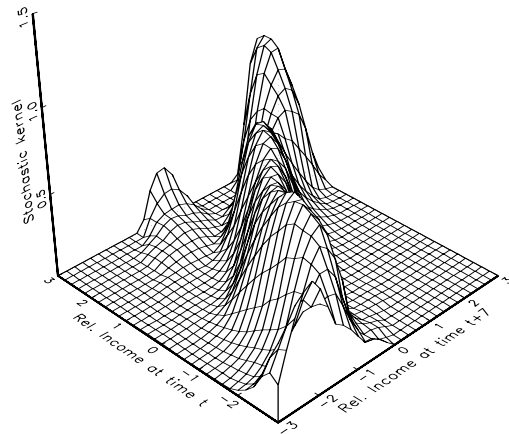
**Figure 1.b Countour plot EU Net Value Added per ha**

Contour plot of estimated stochastic kernel



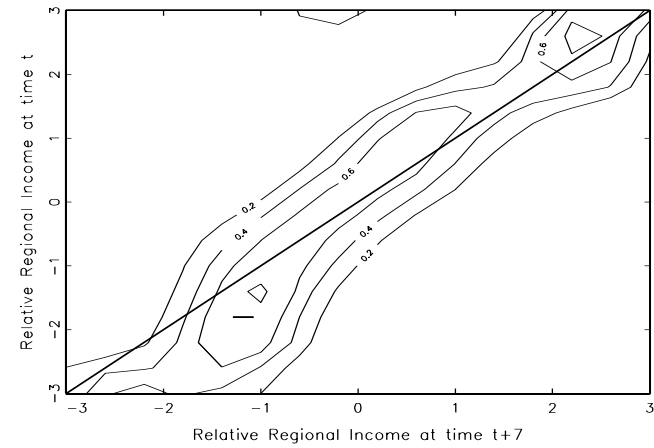
**Figure 2.a Stochastic Kernel EU Family Farm Income per ha**

Stochastic kernel EU Family Farm per hectares : 1989-2002



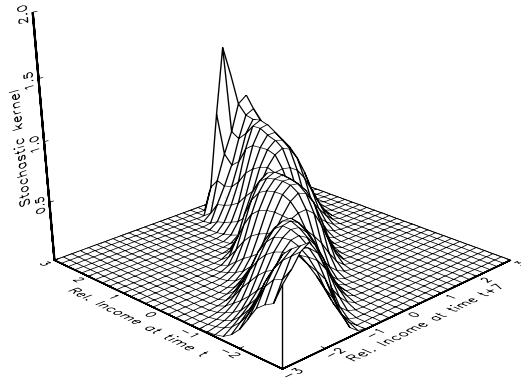
**Figure 2.b Countour plot EU Family Farm Income per ha**

Contour plot of estimated stochastic kernel



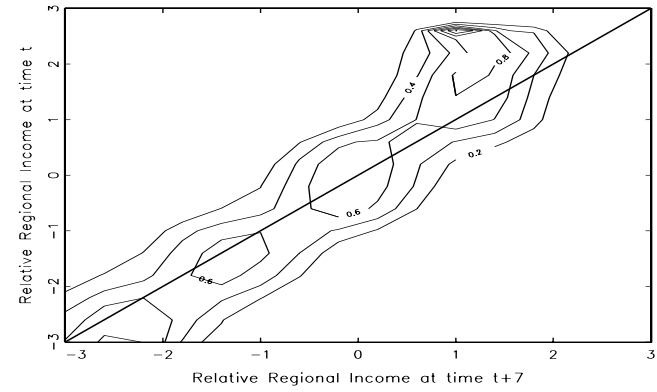
**Figure 3.a Stochastic Kernel US Net Value Added per ha**

Stochastic kernel US Net Value Added per hectares : 1989–2002



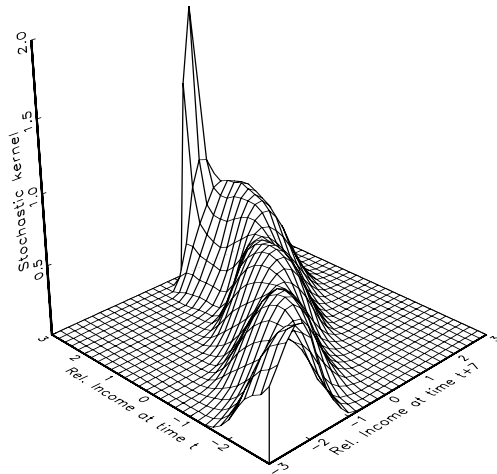
**Figure 3.b Contour plot US Net Value Added per ha**

Contour plot of estimated stochastic kernel



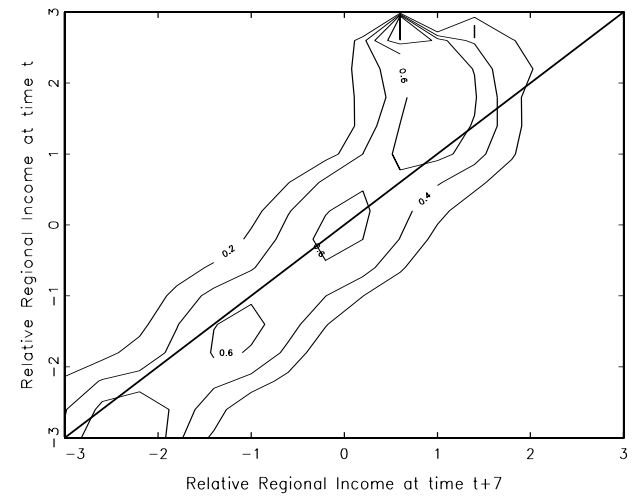
**Figure 4.a Stochastic Kernel US Net Cash Income per ha**

Stochastic kernel US Net Cash Income per hectares : 1989–2002



**Figure 4.b Contour plot US Net Cash Income per ha**

Contour plot of estimated stochastic kernel



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## Appendix A

**Table 1A. The 85 EU regions included in the sample**

( 10) Schleswig-Holstein	(182) Aquitaine	(302) Campania	(520) Navarra
( 20) Hamburg	(183) Midi-Pyrénées	(303) Calabria	(525) La Rioja
( 30) Niedersachsen	(184) Limousin	(311) Puglia	(530) Aragón
( 50) Nordrhein-Westfalen	(192) Rhône-Alpes	(312) Basilicata	(535) Catalana
( 60) Hessen	(193) Auvergne	(320) Sicilia	(545) Castilla-León
( 70) Rheinland-Pfalz	(201) Languedoc-Roussillon	(330) Sardegna	(550) Madrid
( 80) Baden-Württemberg	(203) Provence-Alpes-Côte	(340) Belgi(qu)e	(555) Castilla-La Mancha
( 90) Bayern	(204) Corse	(360) Nederland	(560) Comunidad Valenciana
(100) Saarland	(221) Valle d'Aoste	(370) Danmark	(565) Murcia
(121) Île de France	(222) Piemonte	(411) England-North	(570) Extremadura
(131) Champagne-Ardenne	(230) Lombardia	(412) England-East	(575) Andalucia
(132) Picardie	(241) Trentino	(413) England-West	(610) Entre Douro Minho/Beira litoral
(133) Haute-Normandie	(242) Alto-Adige	(421) Wales	(620) Tras-os-Montes/Beira interior
(134) Centre	(243) Veneto	(431) Scotland	(630) Ribatejo e Oeste
(135) Basse-Normandie	(244) Friuli-Venezia	(441) Northern Ireland	(640) Alentejo e do Algarve
(136) Bourgogne	(250) Liguria	(450) Makedonia-Thraki	(650) Açores
(141) Nord-Pas-de-Calais	(260) Emilia-Romagna	(460) Ipiros-Peloponissos-Nissi Ioniou	
(151) Lorraine	(270) Toscana	(470) Thessalia	
(152) Alsace	(281) Marche	(480) Sterea Ellas-Nissi Egaeou-Kriti	
(153) Franche-Comté	(282) Umbria	(500) Galicia	
(162) Pays de la Loire	(291) Lazio	(505) Asturias	
(163) Bretagne	(292) Abruzzo	(510) Cantabria	
(164) Poitou-Charentes	(301) Molise	(515) Pais Vasco	

**Source: FADN dataset**

## Appendix B

### EU Variable Definitions

*Farm Net Value Added* corresponds to the payment for fixed factors of production (work, land and capital), whether they be external or family factors. As a result, holdings can be compared irrespective of the family/non-family nature of the factors of production employed. This indicator is sensitive, however, to the production methods employed: the ratio (intermediate consumption + depreciation)/fixed factors may vary and therefore influence the FNVA level. For example, in the livestock sector, if production is mostly without the use of land (purchased feed) or extensive (purchase and renting of forage land).

*Family Farm Income* corresponds to the payment for family fixed factors of production (work, land and capital) and the payment for the entrepreneur's risks (loss/profit) in the accounting year. The standard FADN results do not therefore use estimations of the payment for family factors (costs imputed for work, land and family capital).

*Total Utilised Agricultural Area* corresponds to the total utilised agricultural area of holding. Does not include areas used for mushrooms, land rented for less than one year on an occasional basis, woodland and other farm areas (roads, ponds, non-farmed areas, etc). It consists of land in owner occupation, rented land, land in share-cropping. It includes

agricultural land temporarily not under cultivation for agricultural reasons or being withdrawn from production as part of agricultural policy measures.