Do the Spanish regions converge? A unit root analysis for the HDI of the Spanish regions

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This paper analyses to what extent the Spanish regions have undergone a process of convergence since 1980. The application of unit root techniques to the data of the Human Development Index allow us to show that the evolution of the Spanish economy can be understood as a sum of divergent forces, while the *per capita* GDP offers much more evidence in favour of convergence. These insights encourage the use of different economic measures when studying stochastic convergence.

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I. Introduction

The study of economic convergence has recently received a great deal of attention from applied economic researchers because it is a good way of assessing whether economies have diminished their disparities. After the seminal papers of Barro and Sala-i-Martí (1991, 1992), who based their results on the use of cross-sectional techniques, some authors such as Carlino and Mills (1993, 1996), Bernard and Durlauf (1995), Evans and Karras (1996), Loewy and Papell (1996), Nahar and Inder (2002), Strazicich *et al*. (2004) and Carrió-i-Silvestre and Soto (2007), amongst many others, have addressed the issue of economic convergence by studying the stochastic properties of some macroeconomic aggregates. The use of different unit root tests leads these authors to find mixed evidence about whether economies are converging and about the speed of convergence.

All these papers base their results on the use of the regional *per capita* GDP as the most appropriate indicator of the real situation of a particular economy. We should note, however, that the *per capita* GDP cannot capture some interesting aspects related to human welfare and economic potential, including environment, health, education and social integration. Consequently, it seems sensible to consider the use of multidimensional indexes in order to assess the evolution of a particular region or country. An interesting index is the Human Development Index (HDI), which has been published since 1990 by the United Nations Development Programme in its annual Human Development Report. This index provides richer information than the simple *per capita* GDP and, consequently, can offer alternative results in the analysis of convergence between a group of economies.

Against this background, the aim of this paper is to analyse the existence of a convergence process between the Spanish regions using the recently calculated HDI in Herrero *et al*. (2010) for the period 1980-2007. Further, we can compare the results obtained through the use of this index with those obtained with the more standard *per capita* GDP and assess the different results provided by these two measures of development.

The rest of the paper is organized as follows. Section 2 describes the database and Section 3 presents the methodology that will be employed in the paper. Section 4 discusses the results and the paper ends with a review of the most important insights.

II. Data

As we have mentioned earlier, the aim of the paper is to analyse the degree of convergence between the Spanish regions. To that end, we prefer to use the HDI recently calculated by Herrero *et al*. (2010) rather than the regional *per capita* output, although we will employ both of them for comparative purposes. The HDI follows the United Nations recommendations and is based on the idea of Nobel Prize winner Amartya Sen of reflecting capabilities and opportunities more than realizations (see Sen, 1985, in this regard). It can be defined as follows:

$$HDI_t = \frac{1}{3}HI_t + \frac{1}{3}EI_t + \frac{1}{3}MWI_t \qquad t = 1,2,\ldots N \tag{1}$$

where *HI*, *EI* and *MWI* mean a Health Index, an Education Index and a Material Wellbeing Index, respectively. The *HI* uses life expectancy at birth, the *EI* can be obtained as a weighted average of an index of literacy rate and the gross enrolment rate (with weights of 2/3 and 1/3, respectively), and *MWI* is the suitably normalized log of the standard *per capita* GDP.

The values for the Spanish regions are available for the 1980-2007 sample. The regions considered in this paper are: Andalucía (AND), Aragón (ARA), Asturias (AST), Balearic Islands (BAL), Canary Islands (CAN), Cantabria (CAB), Castilla y León (CYL), Castilla-La Mancha (CLM), Cataluña (CAT), Comunidad Valenciana (CVA), Extremadura (EXT), Galicia (GAL), Comunidad de Madrid (MAD), Región de Murcia (MUR), Comunidad Foral de Navarra (NAV), País Vasco (PAV) and La Rioja (LAR).

Finally, we have also considered the value of the *per capita* GDP for both the 17 Spanish regions and the total Spanish economy for the purpose of comparison. A detailed analysis of the differences between these two measures can be found in Herrero *et al*. (2010).

III. Testing for Stochastic Convergence

Following Carlino and Mills (1993) and Bernard and Durlauf (1995), *N* economies are said to converge if it holds that:

$$\lim_{t\to\infty}(y_{it} - \bar{y}_t) = \delta_i \qquad i = 1,2,\dots N \qquad t = 1980,\dots 2007 \tag{2}$$

where y_i denotes the variable employed for the convergence analysis of the *i-th* region and $\bar{y}$ denotes the benchmark variable, both of them expressed in logs. In our present case, convergence is analyzed by the use of both the HDI and the *per capita* GDP, whilst the benchmark is the respective value for the total Spanish economy. Then, convergence is said to be absolute if it holds that $\delta_i = 0$ in (2), while convergence is said to be conditional whenever $\delta_i \neq 0$. We should note that stochastic convergence implies that the differences across economies are not persistent and long-run movements in the regional HDI are driven by common shocks. Thus, the presence of stochastic convergence can be simply tested by assessing the stochastic properties of δ_i. Before discussing the statistics that we will employ to that end, we should take into account that Carlino and Mills (1993) suggest modelling conditional convergence as follows:

$$\delta_{it} = \mu_i + \beta_{it} + u_{it} \qquad i = 1, \ldots, N \qquad t = 1980, \ldots, 2007 \tag{3}$$

where different patterns of behaviour can be defined depending on the values of the parameters μ_i and β_i. If $\mu_i < 0$ and $\beta_i > 0$, this implies that the *i-th* region is growing closer to the HDI benchmark value. Something similar occurs when $\mu_i > 0$ and $\beta_i < 0$, although the *i-th* region is now growing slower than the total Spanish HDI. We will refer to these cases as C^+ and C^-, respectively. These two situations can be considered as *β*-convergence processes, in the sense of Barro and Sala-i-Martin (1991, 1992). Furthermore, we can consider the cases where $\mu_i < 0$ and $\beta_i < 0$, and $\mu_i > 0$ and $\beta_i > 0$. In these two cases, the *i-th* region does not compensate its initial differences with respect to the benchmark values and, therefore, does not converge to them, but rather diverges. Consequently, we will refer to these two cases as D^- and D^+, respectively. Finally, we can also observe situations where $\beta_i = 0$, which implies that the distance with respect to the benchmark values remains unaltered. These last situations can be understood as a weak case of conditional convergence and, therefore, will be referred to as WC^+ and WC^-, when $\mu_i > 0$ and $\mu_i < 0$, respectively.

Testing for unit roots

The previously described methodology requires δ_{it} to be I(0). This can be easily tested by the use of unit root statistics. We should note that there has been a substantial increase in the number of papers devoted to developing methods for testing the unit root null hypothesis since the seminal paper of Dickey and Fuller (1979). Part of this literature takes into account the presence of breaks in the trend function of the variables, especially after the very influential work of Perron (1989). There are several statistics for testing the unit root null hypothesis in the presence of breaks in the trend function. We have opted to use the statistics recently designed in Carrión-i-Silvestre *et al*. (2009), which are based on the use of quasi-generalized least squares detrending methods, following the proposal of Elliot *et al*. (1996). As these authors do, let y_t be a stochastic process generated as follows:

$$y_t = d_t + u_t \tag{4}$$

$$u_t = \alpha u_{t-1} + v_t \qquad t = 0, \ldots, T \tag{5}$$

where d_t reflects the deterministic elements included in the specification. For instance, Elliot *et al*. (1996) consider the presence of an intercept (DFNT0) and an intercept and a linear trend (DFT0). In order to allow for the presence of changes in the deterministic function, d_t should include these changes. Thus, following the most general case reported in Carrión-i-Silvestre *et al*. (2009), which allows for changes in both the slope and in the intercept of the trend function, we can define $DU_t\left(T_b^j\right) = 1$ and $DT_t^*\left(T_b^j\right) = \left(t - T_b^j\right)$ for $t > T_b^j$ and 0 elsewhere, with $T_b^j = [T\lambda_j]$ denoting the *j-th* break date, [·] the integer part, and $\lambda_j \equiv \frac{T_b^j}{T} \in (0,1)$ the break fraction parameter. Then, we have that:

$$d_t = z_t'(\lambda)\psi \tag{6}$$

with $z_t'(\lambda) = [z_t'(T_0), z_t'(T_1), \ldots, z_t'(T_m)]'$ and $\psi = (\psi^{0\prime}, \psi^{1\prime}, \ldots, \psi_m')$. In the present case, $z_t(T_j) = [DU_t(T_j), DT_t^*(T_j)]$ for $1 \leq j \leq m$, with $\psi_j = (\mu_j, \beta_j)'$, with m being the numbers of breaks included in the specification. These authors design some statistics that are based on the use of the quasi-difference variables $y_t^{\bar{\alpha}}$ and $z_t^{\bar{\alpha}}(\lambda)$ defined by

$$y_t^{\bar{\alpha}} = \left(y^1, (1-\bar{\alpha}L)y_t\right), \quad z_t^{\bar{\alpha}}(\lambda) = \left(z^1, (1-\bar{\alpha}L)z_t(\lambda)\right) \tag{7}$$

for $t = 2, \ldots, T$ with $\bar{\alpha} = 1 + \frac{\bar{c}}{T}$ where $\bar{c}$ is a non-centrality parameter. Once the data have been transformed, ψ can be estimated by minimizing the following objective function:

$$S^*(\psi, \bar{\alpha}, \lambda) = \sum \left(y_t^{\bar{\alpha}} - \psi' z_t^{\bar{\alpha}}(\lambda)\right)^2 \tag{8}$$

Although alternative statistics can be employed for testing the unit root null hypothesis, we prefer to use the DF pseudo t-ratio, which can be obtained by estimating the model:

$$\Delta \tilde{y}_t = b_0 \tilde{y}_{t-1} + \sum_{j=1}^{k} b_j \Delta \tilde{y}_{t-j} + e_{tk} \tag{9}$$

and subsequently testing for $H_0\!: b_0 = 0$, with $\tilde{y}_t = y_t - \tilde{\psi}' z_t(\lambda)$ and $\tilde{\psi}$ being obtained by the minimization of (8). The value of *k* has been selected by using the MAIC criteria suggested by Ng and Perron (2001) with the modification proposed by Perron and Qu (2007). The critical values are approximated by way of the estimation of surface responses. In our present case, we will consider a maximum of 3 breaks and the unit root statistics will be referred to as DFT1, DFT2 and DFT3, respectively.

Finally, we should note that we have also employed the statistics proposed in Perron and Vogelsang (1992) and in Clemente *et al*. (1998). These unit root statistics allow for one and two changes, respectively, in the mean but do not include a trend in the specification. These statistics will be referred to as DFNT1 and DFNT2, respectively.

IV. Results

This Section reports the results that we have obtained. In accordance with the methodology previously described, we should first test for the unit root null hypothesis in order to verify the presence of stochastic convergence between the Spanish regions, using both the HDI and the *per capita* GDP as measures of their evolution. Later, we should estimate the appropriate variations of the model (3) for these two variables.

Time series properties: unit roots and breaks

The results obtained from testing the unit root statistics for each of the 17 $\hat{\delta}_i$ are reported in Table 1. The upper part reflects the results for the HDI, whilst the lower part contains the results for the *per capita* GDP. The conclusions are quite similar in both cases. The first important insight that emerges from the inspection of this Table is that the inclusion of breaks is decisive in order to reject the unit root null hypothesis, the 3-break case being the one that provides the greatest number of rejections. However, we should note that the rejection of the unit root null hypothesis is only possible for a liberal 10% significance level for the cases of CAT and MUR when the HDI is used. Similarly, we cannot reject the unit root null hypothesis for BAL when the *per capita* GDP is considered and, consequently, we should conclude that there is no common trend in the evolution of the Spanish GDP and, therefore, there is no stochastic convergence process in this particular case.

β-Convergence

Once we have obtained evidence of the presence of stochastic convergence, we can analyse the particular form that is adopted for each region. To that end, we should estimate the following general model:

$$\delta_{it} = \sum_{k=1}^{m_i+1} \mu_{i,k} DU_{i,k,t} + \sum_{k=1}^{m_i+1} \beta_{i,k} DT_{i,k,t} + u_{it} \qquad (10)$$

$$i = AND, \ldots, LAR \quad t = 1980, \ldots, 2007$$

where $DU_{i,k,t} = 1$ and $DT_{i,k,t} = t - T^{i}_{b,k-1}$ whenever $TT^{i}_{b,k-1} < t < T^{i}_{b,k}$ and 0 otherwise, where $T^{i}_{b,k}$ represents the *k-th* break point estimation, which has been obtained in the previous section. Following Montañés *et al.* (2005), we have taken into consideration the value of the SBIC statistic to select the most appropriate model from among those that are able to reject the unit root null hypothesis.

Given that u_{it} may show some pattern of autocorrelation, there are several procedures to estimate this model which offer similar properties, the standard OLS and the method proposed in Tomljanovich and Vogelsang (2002) being two of the most frequently employed in previous studies. However, Perron and Yabu (2009) have recently developed some new techniques that, according to their Monte Carlo experiments, offer better behaviour than the alternatives considered. Consequently, we have estimated the model (10) by way of the super-efficient median unbiased estimator designed in Perron and Yabu (2009).

Table 2 reflects the estimations of the parameters, where we have removed the estimations of the parameters whose corresponding t-ratio is lower than 1.6. We have also represented the results obtained in Figures 1 and 2. Figure 1 contains the case of the HDI and considers the situation of the regions in 1985, 1995 and 2005, whilst Figure 2 considers the case of the *per capita* GDP.

If we begin by analyzing Figure 1, we can conclude that the results are quite heterogeneous. AND, CVA and GAL show a D^- behaviour for 1985 (Figure 1.a), whilst CAB, PAV, LAR, BAL and ARA show a D^+. Additionally, MAD and CAT remain above the values of the total Spanish economy, whilst EXT and CLM stay below them. Thus, we can observe that only 5 regions reflect β-convergence: AST, MUR and CAN show a C^-, whilst CYL and LAR follow a C^+ process. In 1995, Figure 1.b shows a similar pattern. Again, we can see that only two regions exhibit β-convergence: AST and BAL. The other regions may show either a D^- behaviour (GAL, CLM, MUR and CAN) or a D^+ (CYL and PAV), and may be either below the values of the total Spanish economy (EXT, AND and MUR) or above them (CAB, MAD, LAR, NAV, ARA and CAT). Finally, the picture is even more extreme for 2005 (Figure 1.c). The evidence for β-convergence is reduced to the case of AST, whilst GAL shows absolute convergence. We can also verify that 7 regions diverge: CLM, CVA and BAL with a D^- behaviour and CYL, CAB, PAV and ARA with D^+. The rest do not move with respect to the values of the total Spanish economy: EXT, AND, MUR and CAN are below these values and MAD, LAR, NAV and CAT are above them.

If we now study the convergence when the GDP is used, Figure 2, the results are quite different. Figure 2a shows that AND presents absolute convergence, 5 regions converge (MAD, PAV, MUR and CVA follow a C^- and CAB a C^+), 7 regions diverge (GAL, AST, CYL, EXT and ARA follow a D^- and NAV and CAT a D^+) and the rest do not move away from the values of the total Spanish GDP (LAR and CLM are below these values whilst CAN is above them). The results vary slightly in 1995. Figure 2b shows that CYL reaches absolute convergence with respect to the *per capita* GDP of Spain, β-convergence is proved for 6 regions (MAD, LAR and CAN follow a C^- whilst EXT, ARA and CAT follow a C^+) and 7 regions diverge (GAL, AST, CAB, CLM and MUR follow a D^- and PAV and NAV a D^+). Finally, AND and CVA are below the values of Spain, without showing a trend pattern. If we now consider the case of 2005, Figure 2.c, 5 regions exhibit β-convergence (LAR, CAT and CAN show a C^- process, whilst EXT and CAB follow a C^+), 7 diverge (CLM, MUR and CVA show a D^- process, whilst MAD, PAV, NAV and ARA follow a D^+) and, finally, GAL, AST, CYL and AND do not exhibit any trend and are stable around values which are below those of the total Spanish economy.

As we can infer from this analysis, there are significant changes in the results depending on the variable employed to measure the degree of convergence between the Spanish regions. The use of the *per capita* GDP leads us to conclude that the probability of converging towards the values of the total Spanish economy is relatively high, whilst the cases of divergence are only a third of the total. By contrast, evidence for the β-convergence hypothesis is really low when the HDI is employed, given that most of the regions do not approach towards the values of Spain.

We can compare the two rankings quantitatively by using the Spearman rank correlation coefficient. If we rank the variables according to the estimated value of the parameter β_i and, subsequently, to μ_i, the Spearman rank correlation coefficients are 0.41, 0.47 and 0.38, respectively, for 1985, 1995 and 2005. If we use the *t*-Student approximation, we can verify that this coefficient is only different from 0 for 1995, and only when a liberal 10% significance level is employed. Thus, there is robust evidence against the hypothesis that the two rankings are equal.

More importantly, we can observe that the differences are even greater when the results are interpreted from a global perspective, given that the results of the convergence analysis clearly split Spain into two geographically different zones when HDI is employed. The northern regions broadly show values above the average of the Spanish economy and diverge from them. This can be seen from the warm (red) colours that dominate the north of Spain in Figures 1a-1c. Meanwhile, the values of the HDI for the southern regions are below the values of Spain and also diverge. As a consequence, the evidence for β-convergence is very scant, being lower at the end than at the beginning of the sample. Therefore, the evolution of the total Spanish HDI can be interpreted as the sum of two opposite patterns of behaviour. By contrast, the results obtained with *per capita* GDP are quite different: on the one hand, the evidence for β-convergence is greater and, on the other, the north/south division does not appear to be maintained and, therefore, the total *per capita* GDP can be approximately understood as the sum of convergent forces.

V. Conclusions

This paper has analysed the existence of stochastic convergence for the Spanish regions during the period 1980-2007 comparing the results obtained from using the traditional single-dimensional *per capita* GDP with those obtained from using the multidimensional HDI. The employ of the *per capita* GDP shows mild evidence of β-convergence, which supports previous analyses such as Gardeazabal (1996) or Tortosa *et al*. (2005). However, the situation described by the use of the HDI is quite different. We can see a clear division within Spain, northern regions showing high values of this index while southern regions exhibit low values. Furthermore, both groups show a radicalization of their patterns of behaviour, so that the Spanish HDI can be understood as the sum of two divergent forces. Consequently, the two scenarios are so different that it seems to be highly advisable to combine various types of growth measures when the existence of stochastic convergence between a group of economies is studied.

Finally, we must stress the importance of the results for policymakers. While the use of GDP *per capita* seems to confirm the goodness of the convergence policies adopted in recent years, the use of the HDI casts some doubt on them as they do not seem to have had the desired effect. Moreover, it would be advisable to study the evolution of disaggregated HDI to discover the possible origin of the differences, which could help the policymaker to adopt more efficient convergence policies, a point that is left to future research.

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Table 1. Testing for unit roots

	DFNT0	DFNT1	DFNT2	DFT0	DFT1	DFT2	DFT3
				HDI			
AND	-0.19	-3.58	-3.35	-1.60	-2.25	-5.95[a]	-3.31
ARA	-1.76	-3.65	-3.80	-2.23	-2.83	-4.79[a]	-5.70[a]
AST	-1.35	-2.68	-3.02	-1.47	-2.13	-3.53	-4.09[a]
BAL	0.91	0.08	-1.99	-2.40	-3.45[a]	-4.58[a]	-5.16[a]
CAN	-1.75	-2.76	-5.02	-1.60	-3.43[b]	-3.37	-5.19[a]
CAB	-1.03	-3.34	-3.22	-0.86	-3.72[a]	-3.58[b]	-4.85[a]
CYL	-1.35	-3.45	-5.24	-1.84	-3.25[b]	-3.25	-5.86[a]
CLM	-0.43	-3.15	-4.68	-1.34	-2.24	-5.15[a]	-5.97[a]
CAT	-0.52	-4.43[b]	-4.44	-1.81	-2.27	-3.20	-3.33
CVA	-1.38	-3.51	-4.42	-2.73[b]	-3.92[a]	-4.18[a]	-7.59[a]
EXT	0.11	-2.27	-2.11	-1.92	-2.30	-2.19	-6.46[a]
GAL	0.13	-2.52	-3.71	-1.52	-2.31	-3.67[b]	-6.13[a]
MAD	-1.32	-5.19[a]	-5.87	-1.45	-2.59	-3.32	-2.56
MUR	-1.32	-2.11	-4.01	-1.25	-3.37[b]	-3.64[b]	-3.85[b]
NAV	-2.35[a]	-4.15	-5.85	-2.45	-2.91	-4.28[a]	-5.51[a]
PAV	-0.47	-2.64	-3.62	-1.46	-3.30	-4.42[a]	-4.71[a]
LAR	-1.64	-3.05	-4.59	-1.78	-3.30[b]	-3.66[b]	-4.57[a]
				Per capita GDP			
AND	-1.53	-3.12	-6.65[a]	-1.67	-4.44[a]	-4.87[a]	-4.94[a]
ARA	-0.41	-3.11	-3.55	-2.46	-3.29[a]	-6.01[a]	-5.87[a]
AST	-1.71	-3.32	-4.06	-1.81	-2.89	-3.70[b]	-5.67[a]
BAL	-0.88	-3.04	-3.72	-1.15	-2.69	-2.83	-3.05
CAN	0.14	-1.80	-2.38	-2.74[b]	-2.74	-5.22[a]	-5.08[a]
CAB	-1.79	-4.10	-4.22	-2.14	-2.19	-1.52	-5.90[a]
CYL	-1.55	-4.80[a]	-5.73[b]	-1.62	-4.76[a]	-4.75[a]	-4.01[a]
CLM	-1.06	-3.60	-4.13	-2.33	-2.85	-3.28	-5.88[a]
CAT	-0.96	-3.52	-4.74	-0.98	-2.76	-2.99	-3.74[a]
CVA	0.66	-1.39	-3.48	-2.31	-3.77[a]	-3.71[b]	-6.60[a]

EXT	-0.29	-2.45	-3.01	-2.98 [a]	-2.80	-2.77	-3.74 [a]
GAL	-1.23	-4.26	-4.72	-0.90	-1.72	-3.71 [b]	-5.20 [a]
MAD	-1.86	-3.55	-3.81	-2.25	-2.30	-3.59	-4.82 [a]
MUR	-0.24	-2.29	-3.04	-3.65 [a]	-3.80 [a]	-4.19 [a]	-5.16 [a]
NAV	-2.16	-3.51	-6.48 [a]	-2.11	-3.05	-5.68 [a]	-2.94
PAV	-1.63	-2.81	-3.26	-1.34	-3.16 [b]	-4.23 [a]	-4.25 [a]
LAR	-1.74	-5.02 [a]	-6.21 [a]	-2.09	-3.11	-3.01	-5.92 [a]

This Table reflects the results of applying the unit root tests to the δ_{it} when this variable is obtained by way of both the HDI and the *per capita* GDP.
DFNT, DFNT1 and DFNT2 denote the DF-GLS, the Perron-Vogelsang and the Clemente-Montañés-Reyes statistics, respectively. None of them include a deterministic trend in the specification, whilst the last two consider the presence of 1 and 2 changes in the mean.
DFT denote the DF-GLS obtained by including a trend in the specification. DFT1, DFT2 and DFT3 are the Carrión-i-Silvestre-Kim-Perron statistics for 1-3 changes in both the intercept and the slope of the trend function.
[a] and [b] means the rejection of the unit root null hypothesis for a 5% and a 10% significance level, respectively.

Table 2: β -Convergence

	μ_1	β_1	TB1	μ_2	β_2	TB2	μ_3	β_3	TB3	μ_4	β_4
						HDI					
AND	-0.018	-0.007	1986	-0.032	.	1997	-0.027	.	.	.	.
ARA	-0.015	0.008	1984	0.012	0.001	1994	0.010	.	2001	.	0.002
AST	.	0.001	1984	0.011	-0.001	1998	-0.007	0.002	2003	-0.005	0.002
BAL	0.011	0.000	1990	0.005	-0.001	2004	-0.003	-0.004	.	.	.
CAN	.	-0.003	1986	-0.012	.	1992	.	-0.003	1999	-0.015	.
CAB	0.008	0.003	1985	.	0.006	1988	0.014	.	1996	.	0.001
CYL	-0.010	0.005	1985	0.008	0.001	1997	.	0.002	2002	.	0.003
CLM	.	-0.014	1983	-0.030	.	1990	-0.017	-0.001	2003	.	-0.006
CAT	0.015	.	2003	0.014	.	.	.	.	.	.	.
CVA	.	-0.002	1985	-0.006	-0.001	1996	-0.005	-0.002	2003	.	-0.004
EXT	.	-0.030	1983	-0.056	.	1993	-0.029		2000	-0.027	.
GAL	.	-0.003	1985	-0.015	.	1993	-0.006	-0.001	2001	.	.
MAD	0.019	.	1995	0.020	.	.	.	.	.	.	.
MUR	0.032	-0.007	1987	-0.029	.	2002	-0.014	.	.	.	.
NAV	.	0.005	1986	.	0.012	1990	0.018	.	1996	0.021	.
PAV	-0.049	0.023	1983	0.020	0.003	1989	0.023	.	1995	0.024	0.002
LAR	-0.021	0.008	1985	.	0.003	1994	0.014	.	2001	0.009	.
						Per capita GDP					
AND	.	.	1992	-0.238	.	2001	-0.198	.	.	.	.
ARA	-0.108	0.011	1983	.	-0.013	1987	-0.018	0.005	1997	0.008	0.006
AST	.	-0.037	1985	.	-0.042	1991	-0.089	-0.022	1998	-0.185	.
BAL	.	.		.	.	.	.	.	1993	.	
CAN	.	0.034	1983	.	.	1985	0.073	.	1992	0.062	-0.011
CAB	0.033	-0.007	1985	-0.066	0.009	1989	-0.019	-0.011	1996	-0.095	0.004
CYL	0.695	-0.305	1982	-0.251	.	1985	-0.261	.	1988	-0.173	-0.004
CLM	.	-0.030	1984	.	-0.020	1992	.	.	1997	-0.104	.
CAT	-0.346	0.132	1982	0.049	0.032	1984	0.104	0.009	1994	0.191	-0.002

CVA	0.065	-0.025	1982	0.012	-0.003	1993	-0.046	.	2000	-0.022	-0.013
EXT	-0.284	-0.149	1983	0.931	-0.932	1985	-0.049	-0.196	1988	-0.515	0.008
GAL	.	-0.070	1985	-0.122	-0.029	1992	-0.118	-0.027	1999	-0.196	.
MAD	0.214	0.008	1985	0.297	-0.003	1997	0.265	0.010	2001	0.252	0.005
MUR	0.111	-0.024	1988	.	.	1990	-0.015	-0.023	1994	-0.095	-0.007
NAV	0.147	0.014	1988	0.092	0.042	1992	0.149	0.008	.	.	.
PAV	-0.423	0.225	1982	0.258	-0.016	1988	0.168	-0.009	1993	0.096	0.010
LAR	-0.127	0.038	1985	-0.076	.	1989	.	0.033	1993	0.122	-0.004

This Table reflects the estimation of mode (10) by way of the super-efficient median unbiased estimator designed in Perron and Yabu (2009). TBi (i=1,2,3) are the estimated break fractions obtained from the unit root tests reported in Table 1.

Figure 1. β -convergence analysis for HDI

Figure 1.a.1985

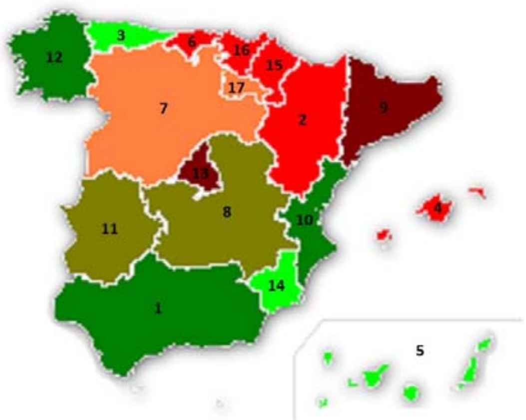


Figure 1.b. 1995

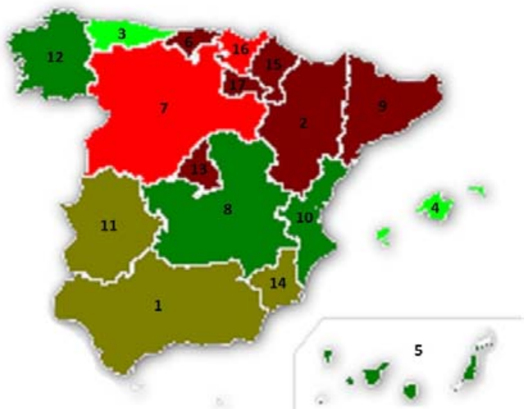


Figure 1.c. 2005

Figure 2. β -convergence analysis for *per capita* GDP

Figure 2.a. 1985

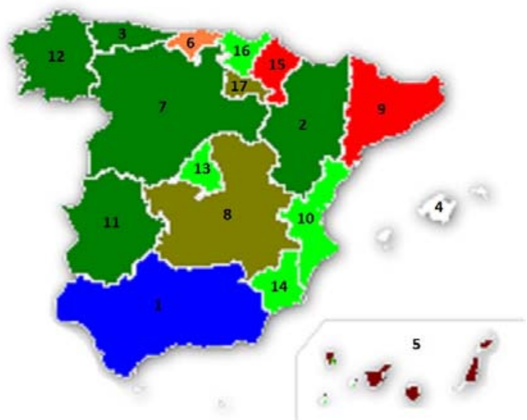


Figure 2.b. 1995

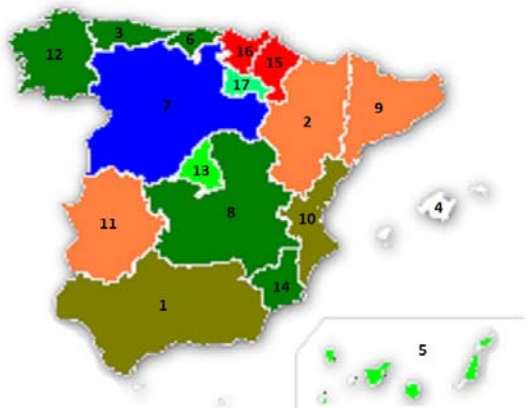
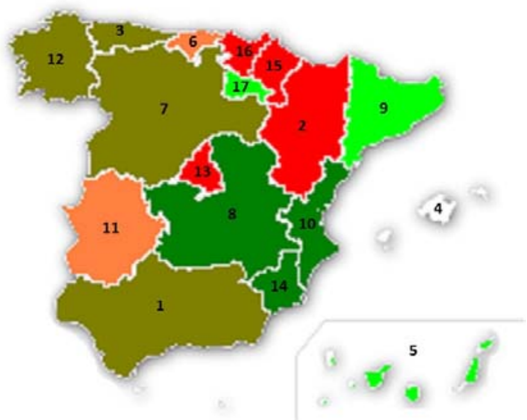


Figure 2.c. 2005



1	AND	7	CYL	13	MAD
2	ARA	8	CLM	14	MUR
3	AST	9	CAT	15	NAV
4	BAL	10	CVA	16	PAV
5	CAN	11	EXT	17	LAR
6	CAB	12	GAL		

Divergence D^-
Weak Conditional Divergence WC^+
Convergence C^-
Absolute Convergence
Convergence C^+
Weak Conditional Divergence WC^-
Divergence D^+