Do the Spanish regions Converge? A unit root analysis for the HDI of the Spanish Regions.*

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Abstract

This paper analyses to what extent the Spanish regions have shown a convergence process since 1980 to nowadays. The application of the unit root techniques to the HDI recently developed by IVIE lead us to show that the convergence process has not been similar in all the regions, even some of them has exhibit divergence process. However, Extremadura, Andalucia, Castilla-La Mancha and Galicia show a clear convergence process and have reduce the HDI distance. By contrast, Pais Vasco have shown a divergence process.

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1 Introduction

The study of the economic convergence phenomenon has been undertaken from the time series approach. The contribution of this methodology to the growth of theory is important because it constitutes a fine way of assessing whether the economies have diminishing returns to scale. If evidence in favour of economic convergence is found, then the economies would not grow indefinitely. Instead, they are expected to catch up each other given the presence of diminishing returns to scale. 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 Pesaran (2007) among others, have addressed the issue of economic convergence assessing the stochastic properties of macroeconomic aggregates in a cross-state comparison framework. These papers have found mixed evidence about whether economies are converging and about the convergence speed. Economic convergence can be seen as a multidimensional phenomenon, where the different sectors of the economy can contribute in different ways. In this case, it would be interesting to have evidence on economic convergence that is based on disaggregated sectors of the economy.

All these papers based their results on the use of the regional output as the most appropriate indicator of the existence of convergence. We should note, however, that this variable does not always capture the evolution of the economy in an appropriate way. To see this, let us think about cases such us Guinea where a clear growth process can be observed, but this only benefits to a small proportion of the population. This could be solved by using some measures based on the regional output that took into account the distribution of wealth. However, this new indicator could not capture the evolution in other aspect such as the human capital or the life expectancy, which are crucial in order to assure the existence of a convergence process. Rather, the use of a different indicator, such is the case of the Human Development Index, seems to be much more appropriate in this regard.

The Human Development Index (HDI) is published since 1990 by the United Nations Development Programme in its annual Human Development Report (HDR). This has made possible to study convergence among countries, using a comprehensive measure of development than per capita income. Based on the HDI, recently Mazumdar (2002) and Noorbakhsh (2006) tackled this issue, and our paper is a further step in this direction. In particular, the aim of this paper is to analyze the existence of a convergence process of the case of the Spanish Regions, using the results obtained by Herrero et al. (2010) of the 1980-2007 period. These indexes are based on the use of more appropriate techniques that are discussed in Herreto et al (2010a and

2010b).

The rest of the paper is organizing as follows. Section 2 describes the evolution of the HDI for the different Spanish regions. Section 3 presents the definition of the concept of stochastic convergence and discusses the econometric methods taht will be used. Section 4 analyses the results obtained and the paper ends with a review of the most important results.

2 Stochastic Convergence: Definition and Testing Methodology

This Section is devoted to present the methodology that we will employ across the paper. First, we present the definition of Stocastic convergence that we will use, later the method for testing its presence and, finally, the way that we will estimate the convergence relationship.

2.1 Stochastic Convergence Definition

Barro and Sala-i-Martin (1991, 1992) were the first who introduced the notion of β and σ convergence to assess whether the poor states (or countries) grow faster than the richer ones, implying that they will catch up (β-convergence) in the long-run, or whether the dispersion of the income diminishes (σ-convergence) over time. However, the econometric validity of these cross-section based approaches was questioned by Quah (1993), Carlino and Mills (1993), Bernard and Durlauf (1995), and Evans (1998), who defend the use of time series methods given that the cross-section approach is subject to bias (Quah 1993). In what follows we describe the main time series based approaches to analyse the presence of convergence. Although the concept was initally related to regional output, in what follows we will adapt the definition to the case of the HDI, the variable that will be used in the present paper.

Following Bernard and Durlauf (1995), N economies are said to converge if, and only if, a common trend a_t and finite parameters δ_1, δ_2, . . ., δ_N exist so that:

$$\lim_{t\to\infty} (y_{it} - a_t) = \delta_i \tag{1}$$

where for $i = 1, ..., N$, where y_{it} denotes the value of the HDI of the $i-th$ time series. In order to account for the unobservable common trend, we

define the average of the N economies so that:

$$\lim_{t\to\infty} (\bar{y}_t - a_t) \;=\; \frac{1}{N}\sum \delta_i \tag{2}$$

where $\bar{y}_t = N^{-1}\sum y_{it}$ denotes the average of the HDI−the benchmark time series. If we define the level of the common trend so that $\lim_{t\to\infty} (\bar{y}_t - a_t) = 0$, and subtracting (2) from (1), stochastic convergence exists if, and only if,

$$\lim_{t\to\infty} (y_{it} - \bar{y}_t) \;=\; \delta_i \tag{3}$$

We should note that convergence is said to be absolute if, and only if, the unconditional mean $\delta_i = 0$ in (3), while convergence is said to be conditional when $\delta_i = 0$ in (3). Bernard and Durlauf (1995) state that stochastic convergence occurs when the HDI of one economy relative to the benchmark economy is I(0) stationary. Thus, stochastic convergence implies that differences across economies are not persistent, and long-run movements in regional HDI are driven by common shocks. In this case, the presence of stochastic convergence can be tested by assessing the stochastic properties of $y_{it} - \bar{y}_t$ using unit root and stationarity test statistics.

In order to capture deviations from relative trend growth, Carlino and Mills (1993) propose to model deviations from the equilibrium (δ_{it}) as the combination of a time trend and a stochastic process:

$$\delta_{it} = \; \mu_i + \; \beta_i \; t + \; u_{it} \tag{4}$$

Therefore, regional output (y_{it}) is said to converge to the average of regional HDI ($\bar{y}_t$) if $y_{it} - \bar{y}_t$ is I(0) stationary, which requires u_{it} in (4) to be I(0). Thus, β-convergence requires that if a region is initially above its compensating differential (μ_i), it should grow more slowly than the benchmark, which implies $\beta_i < 0$ in (4). On the other hand, if the region is initially below its compensating differential, then $\beta_i > 0$ in (4).

2.2 Testing for unit roots

Since the seminal paper of Dickey and Fuller (1979), there has been a enormous increment of papers devoted to develop methods for testing the unit root null hypothesis. A part of this literature takes into account the presence of breaks in the trend function of the variables, given the problems caused in the inference by its omission, as is alerted by the very influential work of Perron (1989).

Let y_t be a stochastic process generated according to

$$y_t = d_t + u_t \tag{5}$$

$$u_t = \alpha u_{t-1} + v_t, t = 0, ..., T \tag{6}$$

Following Carrión et al (2009, we consider three models: Model 0 ("level shift" or "crash"), Model I ("slope change"or "changing growth"), and Model II ("mixed change"). If we additionally consider that $DU_t(T_j) = 1$ and $DT_t^*(T_j) = (t - T_j)$ for $t > T_j$ and 0 elsewhere, with $T_j = [T\ \lambda_j]$ denoting the j-th break date, with $[\cdot]$ the integer part, and $\lambda_j \equiv T_j/T\ \in (0, 1)$ the break fraction parameter. Accordingly, The deterministic component in (5) is given by

$$d_t = \ z_t'(\lambda)\ \psi \tag{7}$$

with $z_t'(\lambda) = \ [z_t'(T_o), z_t'(T_1), ..., z_t'(T_m)]'$ and $\psi = \left(\psi_0^{'}, \psi_1^{'}, ..., \psi_m^{'}\right)$, where

$$z_t(T_j) = \begin{array}{c} DU_t(T_j) \text{ for model 0} \\ DT_t^*(T_j) \text{ for model I} \\ [DU_t(T_j), DT_t^*(T_j)] \text{ for model II} \end{array} \tag{8}$$

for $1 \leq j \leq m$, with $\psi_j = \mu_j$ in model 0, $\psi_j = \beta_j$ in model I, and $\psi_j = \left(\mu_j,\ \beta_j\right)'$ in model II.

Carrión et al. (2009) defines a GLS statistic that is based on the use of the quasi-difference variables $y_t^{\bar{\alpha}}$ and $z_t^{\bar{\alpha}}(\lambda)$ defined by

$$y_t^{\bar{\alpha}} = (y_1,\ (1 - \bar{\alpha}L)y_t), \quad z_t^{\bar{\alpha}}(\lambda) \ = \ (z_1,\ (1 - \bar{\alpha}L)z_t(\lambda)) \tag{9}$$

for $t = 2, ..., T$ with $\bar{\alpha} = 1 + \bar{c}/T$ where $\bar{c}$ is a non-centrality parameter. Once the data has been transformed, the ψ parameters, associated with the deterministic components, can be estimated by minimizing the following objective function

$$S^*(\psi, \bar{\alpha}, \lambda) = \ \sum \left(y_t^{\bar{\alpha}} - \psi' z_t^{\bar{\alpha}}(\lambda)\right)^2 \tag{10}$$

3 Results

The results that we have obtained are reported in the present Section. According to the methodology previously described, we should first test for the unit root null hypothesis in order to verify the existence of a relatioship between the HDI of a region with respect to the HDI of Spain. Later, we

should estimate the model () and verify whether a convergence or a divergence process exist.

3.1 Time Series Properties: Unit Roots and Breaks

The results obtained from the use of the unit root statistics are reported in Table I. The first important result that emerges from the inspection of this Table is that the inclusion of breaks comes into vital in order to reject the unit root null hypothesis. In fact, we can only reject the unit root hypothesis for 4 regions (Balearic Islands, Cantabria, Comunidad Valenciana and La Rioja), whilst the inclusion of breaks in the trend function allows us for rejecting for a total of 14 regions, being the inclusion of 3 breaks the one that provides a greater number of rejections. We have mentioned that we cannot reject the unit root null hypothesis for 3 regions: Madrid, Cataluña and Murcia. We should note however that some values of the statistics are close to their correspondent 5% significance value. The clearest example is the case of Murcia. For this region, the value of the CKP statistic for $m = 2$ is -3.64 whilst the 5% critical value is -3.78. Thus, it seems to be clear that the use of a more liberal 10% significance level would provide us some mild evidence against the unit root null hypothesis. Thus, our results provide a robust conclusion in favour of the existence of a clear degree of relationship between the HDI for the Total Spanish EConomy and the correspondent value of this index for the Spanish Regions.

Breaks

3.2 β-Convergence Results

The estimation of the model () for the different regions are presented in Table II. As we can easily observe, the results are far from being homogeneous and there is not clear evidence in favour of the existence of a common convergence (or a divergence) process in the evolution of the regional HDI. Rather, it is habitual the presence of periods where the distance between a particular regional HDI goes closer to the national HDI, which would imply convergence, following by peridos where this distance is increased (divergence). In spite of this heterogenous behaviour, some clear insights emerge.

Let us begin by the case of Andalucía and Extremadura. These two regions show the lowest values of the HDI at the beginning of the sample. They exhibit a great amount of convergence, although their speed is not similar. Extremadura presents higher estimated values of the trend parameters than

those of Andalucía, specially during the periods 1983-1992 and 2000-2007, when these estimated values exceed 0.2. The rythm of convergence of Andalucía is quick in the period 1980-1985, but cannot mantain the speed of approximation to the HDI values of the total Spanish economy during the rest of the sample.

The case of Castilla-La Mancha is quite similar to the previously commented. This region shows a small value of the HDI at the beginning of the sample and the results of Table II confirms the presence of a clear process of convergence. However, we should note that this region starts this convergence process in 1983 and it is indeed very intense during the period 1984-1990 and much more moderate during the noughties. During the 1990's, there is not any evidence in favour of a convergence process. Rather, the HDI values diverge, although the speed of divergence is small in that the estimated value of the trend parameter is -0.04. A similar picture can be defined for Galicia. This region also presents an overall convergence process, although this begins in 1986, has a period where it almost disappears (1993-2001), with a estimated value of the trend parameter negative (-0.01). However, this value is so close to 0 that cannot be considered as a period of divergence. Finally, the speed of convergence is recovered during the last part of the sample.

All the previous regions show a clear convergence process, diminishing the distance between its values and those of the HDI for the total Spanish. We can also observe the existence of difference convergence process. In this case, it is not so positive for the regions involved, in that it implies an worsening of their relative position with respect to the rest of Spain. This is the case of Cataluña and the Balearic Islands. These regions show a comparatively good position in 1980, but this distance has diminished during the considered sample. However, the intensivity of this process is not similar both them. The HDI of Cataluña grows clearly slowier than the resto of Spain during the periods 1980-1992 and 2003-2007, being the estimations of the trend parameters relatively high in absolute values (-0.12 and -0.18, respectively). By contrast, the estimation of the trend value goes towards 0 during the intermediate period (1993-2002). The case of the Balearic Islands is a bit different, in that the speed of convergence is quite similar during the period 1980-2003, with estimated values of the trend parameter being close to -0.10, whilst the last period, 2004-2007, this estimated values is -0.4. This losing of his position is clearly understood if we consider that the HDI of this region can hardly grow 0.2 points during this period, while Spain grows 1.1 points.

Another interesting case is that of those regions that do not show convergence, but rather diverges. We can again observe two different types of divergence: improving its relative position against Spain or enworsening it. There is not a clear evidence in favour of any of these two types, at least

when the whole sample is considered. However, the case of Murcia is similar to former, whilst Pais Vasco to the latter. To see this, we should note that Murcia shows a clear divergence process for the period 1990-1987, growing 0.5 points below the rest of Spain. The period 1998-2003 shows a better behaviour of Murcia, converging its values to those of the rest of Spain, although with a slow speed (the estimation of the trend parameter is 0.04), whilst the last part of the sample (2004-2007) the HDI of Murcia similarly grows to the rest of Spain. The HDI of the Pais Vasco shows a different pattern of behaviour. It exhibits a divergence process, growing its HDI faster than that of the rest of Spain during the period 1980-1989, especially since 1983. Later, 1990-1995, the HDI of the Pais Vasco converges towards the Spanish values at at moderate speed (the estimation of the trend parameter is 0.04), whilst it again diverges since 1996, with a relatively high value of the estimation of the trend parameter (0.08). As a result of this process, the distance of the HDI of the Pais Vasco and that of Spain increases from 2.8 points in 1980 to 4.0 in 2007, showing the highest value of all the Spanish regions.

The behaviour of the rest of the regions is quite heterogeneous and the periods of convergence and divergence follows one another. A very clear example of this, it is the case of Madrid, which exhibits a convergence process during the period 1980-1996, although the estimated value of the trend parameter is small (-0.04) and could be considered that both HDI grows at the same speed. Divergence dominates the period 1997-2001, with a estimation of the trend parameter slighly higher than the observed in the previous period (0.08), whilst convergence can again observe since 1992, with a estimation of the trend parameter similar in magnitude to the previous one, although negative (-0.09).

4 Conclusions

This papers has analysed the existence of a convergence process for the Spanish Regions during the period 1980-2007. To that end, we have applied unit root tests that allow for the presence of breaks in the trend funcion to the evolution of the HDI of the Spanish Regions. When the evolution of the HDI for the total Spanish economy is employed as a benchmark, our results proved the existence of a clear convergence process for Andalucía, Galicia and Castilla-La Mancha and, especially, Extremadura. All these regions have clearly improved its relative position against the rest of Spain. Cataluña and Madrid also present some evidence in favour of this convergence process, although these results imply a lost of the relative position. By contrast, Pais

Vasco and Murcia show divergence. For the rest of the Regions, the results are not very conclusive and should analyzed more carefully.

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Table I. Testing for unit roots.

	m=0	5% CV	m=1	5% CV	TB1	m=2	5% CV	TB1	TB2
Andalucia	-2.31	-3.45	-2.25	-3.41	1985	-5.95	-3.86	1985	1997
Aragón	-2.83	-3.37	-2.83	-3.32	1983	-4.79	-3.86	1984	1995
Asturias	-2.17	-3.11	-2.13	-3.34	1998	-3.53	-3.83	1984	1998
Balearic Islands	-4.14	-3.21	-3.45	-3.38	1996	-4.58	-3.69	1990	2004
Canary Islands	-2.45	-3.41	-3.43	-3.44	1991	-3.37	-3.86	1986	1992
Cantabria	-3.41	-3.32	-3.72	-3.38	1996	-3.58	-3.81	1982	1996
Castilla-Leon	-2.37	-3.41	-3.25	-3.36	1997	-3.25	-3.86	1985	1997
Castilla-La Mancha	-1.93	-3.45	-2.24	-3.43	1992	-5.15	-3.74	1988	2003
Cataluña	-2.29	-3.45	-2.27	-3.42	1993	-3.20	-3.70	1993	2003
C. Valenciana	-4.42	-3.43	-3.92	-3.41	1985	-4.18	-3.73	1985	2003
Extremadura	-3.10	-3.45	-2.30	-3.32	1983	-2.19	-3.85	1983	1993
Galicia	-2.48	-3.26	-2.31	-3.26	2001	-3.67	-3.79	1990	2001
Madrid	-1.68	-3.29	-2.59	-3.38	1996	-3.32	-3.67	1996	2001
Murcia	-3.12	-3.44	-3.37	-3.44	1987	-3.64	-3.78	1987	2002
NAvarra	-2.69	-3.45	-2.91	-3.43	1986	-4.28	-3.84	1986	1991
Pais Vasco	-3.02	-3.36	-3.30	-3.39	1995	-4.42	-3.86	1989	1995
La Rioja	-3.45	-3.41	-3.30	-3.45	1989	-3.66	-3.88	1985	1994

This table reports the results obtained for testing the unit root null hypothesis. When m=0, the ADF-GLS statistic is employed, whilst m=1,3, the statistic used is the version of this statistic proposed in Carrion et al. (2009) for different number of breaks. TBi represents the estimation of the period where the break appears, whilst 5% CV means the estimated 5% significance value of the statistic.

Table II. Estimation of the trend function

	a_1	b_1	TB_1	a_2	b_2	TB_2	a_3	b_3	TB_3	a_4
Andalucia	-5.34	0.11	1985	-4.83	0.04	1997	-5.05	0.08		
Aragón	0.60	0.24	1984	0.42	0.02	1995	-0.06	-0.01		
Asturias	0.15	0.05	1984	0.88	-0.09	1998	0.33	0.17	2003	-0.27
Balearic Islands	1.11	-0.06	1985	1.45	-0.10	1996	1.70	-0.10	2004	1.97
Canary Islands	-1.48	-0.06	1986	-1.83	0.20	1992	-1.51	-0.13	1999	-2.13
Cantabria	1.65	0.22	1982	1.52	-0.10	1996	0.93	0.10		
Castilla-Leon	0.28	0.17	1985	0.15	0.05	1997	-0.30	-0.01	2002	-0.34
Castilla-La Mancha	-4.12	0.01	1983	-4.21	0.27	1990	-4.25	-0.04	2003	-3.47
Cataluña	2.88	-0.12	1993	3.06	0.00	2003	3.15	-0.18		
C. Valenciana	-0.60	-0.01	1985	-0.93	-0.02	2003	-0.62	-0.05		
Extremadura	-8.46	0.13	1983	-7.78	0.23	1993	-8.12	0.10	2000	-8.58
Galicia	-1.46	0.00	1985	-2.10	0.11	1993	-2.07	-0.01	2001	-1.93
Madrid	4.00	-0.03	1996	4.62	0.08	2001	3.78	-0.09		
Murcia	-1.12	0.14	1987	-2.02	0.04	2002	-1.52	0.00		
NAvarra	3.37	-0.09	1986	3.66	0.25	1990	3.52	-0.16	1996	3.86
Pais Vasco	3.22	0.04	1983	2.91	0.10	1989	2.71	-0.05	1995	2.55
La Rioja	0.62	0.26	1985	-0.45	0.21	1994	-1.34	0.02	2001	-1.75

This table reports the results obtained from the estimation of model (XX).