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Abstract

We study the possible existence of convergence across the Spanish provinces, paying special attention to the influence the recent international crisis has had on this process. To this end, we have taken the traditional per capita GDP as well as the multidimensional index of human development as a reference. Our results show that the convergence pattern has been clearly modified by the crisis; the differences are greater in 2014 than in 2007. Nevertheless, a greater effect of the crisis has not been observed on predominantly urban provinces, in contrast to what other authors have found in the case of Europe.

Keywords: Convergence; Human Development Index; Urban provinces; Crisis.

JEL Classification: C22; R10; O47.

1. 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 et al., 1991, and BARRO and SALA-I-MARTÍ, 1992, who based their results on the use of cross-sectional techniques, some authors such as CARLINO and MILLS, 1993, CARLINO and MILLS, 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 situation in 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 health, education and social integration. Consequently, it seems to be sensible to consider the use of multidimensional indexes in order to assess the evolution of a particular region or country, especially if the current economic environment is based on the application of austerity policies that affect education or health care, among others. 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 information about the capacities of a particular economy and not about realizations as the simple GDP. Consequently, the HDI can offer alternative results in the analysis of convergence among groups of economies.

An example of the use of this index to test for convergence is the recent paper by MONTAÑÉS and OLMOS, 2014. These authors compare the results of the convergence

analysis for the Spanish regions when both GDP and HDI are used. Two main results emerge from that paper. First, the results obtained from the use of GDP and HDI exhibit some differences at the end of the sample (2000), but they tend to show similar results at the beginning of the sample. Consequently, this result invites us to use both variables to analyze convergence, given its marked complementary relationship. Secondly, the evolution of the Spanish regions can be better understood as the addition of some divergent patterns of behavior rather than the presence of a real convergence process, suggesting the existence of some convergence clubs, an interesting question that the authors cannot solve using the unit root techniques. Nevertheless, the sample used by these authors covers the period from 1980-2010. Therefore, the total effects of the economic crisis that Spain has suffered since 2008, like the rest of the economies, cannot be properly assessed and that could have had an impact on the aforementioned convergence process. It is possible that the crisis may have increased the differences and, therefore, the diverging behaviors have worsened, or, on the other hand, that the distances have been reduced. In any case, there is no information on the impact of the crisis on the convergence process and, consequently, it seems appropriate to analyze the behavior of Spain over this period. Against this background, the aim of this paper is to analyze the influence of the recent economic crisis on the convergence process in Spain.

The rest of the paper is organized as follows. Section 2 describes the database. Section 3 presents the methodology that will be employed in the paper and the results obtained from the convergence analysis. Section 4 explores the sources that generate the different clubs of behavior. The paper ends with a review of the most important insights.

2. The effect of the crisis on the Spanish provinces: data and descriptive analysis

As we have previously stated, the objective of this paper is to analyze whether the recent international crisis has affected in some way the convergence process in the Spanish provinces. Therefore, it is necessary to decide on which variable to study in the convergence

process since we can employ different measurements on the evolution of a particular province. Most of the previous convergence papers are based on the use of the per capita GDP. Nevertheless, this measurement can hide the effect on other essential aspects of the evolution of a society, especially if we take into account that the provincial, regional and central governments have taken austerity measures aimed at reducing the deficit of the public administrations, which consequently has had restrictive effects on public health and education. Subsequently, it is foreseeable that the crisis has altered not only the levels of economic wellbeing, but also health and education attained since the 1980s. Thus, it seems advisable to use an indicator that takes into account these three aspects: material wellbeing, health and education, as is the case with the well-known Human Development Index (HDI). This index is based on the idea of Amartya Sen of reflecting capabilities and opportunities more than realizations (see SEN, 1985). Its definition has recently changed and the current version of this index can be stated as follows:

$$HDI_{it} = \sqrt[3]{HI_{it} * EI_{it} * MWI_{it}} \qquad t = 1,2,\dots,N \tag{1}$$

where HI, EI and MWI mean a Health Index, an Education Index and a Material Wellbeing Index, respectively. The HI depends on the life expectancy at birth (LE) and is defined as follows:

$$HI_{it} = \frac{LE_{it} - \min LE}{\max LE - \min LE} \tag{2}$$

with $\min LE$ and $\max LE$ being equal to 20 and 85 years, respectively. The education index is obtained as follows:

$$EI_{it} = \frac{MYSI_{it} + EYS_{it}}{2} \tag{3}$$

where $MYSI$ represents mean years of schooling index (MYS) and EYS is the expected years of schooling index. These indexes are obtained as follows:

$$MYSI_{it} = \frac{MYS_{it}}{15} \quad (4)$$

$$EYSI_{it} = \frac{EYS_{it}}{18} \quad (5)$$

Finally, MWI is an income index that can be defined as follows:

$$MWI_{it} = \frac{\ln(GNI_{it}) - \ln(100)}{\ln(75{,}000_{it}) - \ln(100)} \quad (6)$$

where GNI_{it} is the Gross National Income of each *i-th* province at period *t*.

Throughout this paper we will combine the use of the more standard per capita GDP with the use of the HDI that, in our view, can help us better understand the type of effects that the crisis has had on the Spanish convergence process.

Having defined the variables that we will focus on, the next problem we face is the type of territorial disaggregation to be used. In our view, it seems advisable to use the most disaggregated information as possible, whenever data permits. Combining both premises, it seems appropriate to use provincial data (which is equivalent to the TL3 used by the OECD or to the NUTS-3 defined by Eurostat). It is true that the majority of papers usually use less disaggregated data, as is the case of a regional analysis. However, we should take into account that the use of regional data may not sometimes provide very useful insights. Here we are considering those cases where the regional division includes infra-regional territorial structures, such as provinces or cities that behave heterogeneously. Given that the regional data is a weighted average of all of them, the conclusions based on regional data cannot be very informative. This is clear in the Spanish case, where the regional structure is composed of a great variety of provinces whose behavior is far from being similar within a region. For instance, we can consider the case of Aragon. This region has their main focus of activity on the cities of Huesca, Teruel and Zaragoza. The activity in this region is mainly focused on the cities of Huesca, Teruel and Zaragoza, which give the name to the three homonymous provinces. The population of the city of Zaragoza represents 50% of the population of

Aragon, whilst this percentage rises to 72% if we consider the province of Zaragoza. Furthermore, the regional productive structure is not similar if we analyze it from a provincial perspective. For instance, the weight of the manufacturing industry in Zaragoza almost doubles that of Huesca and Teruel. Similarly, the contribution of the Agriculture sector to the GDP is clearly higher in Huesca and, to a very lesser extent, in Teruel than in Zaragoza. Therefore, the conclusions that emerge from a regional analysis cannot offer insights as rich as those obtained from a more disaggregated study, especially as far as the active growth policies are concerned.

Having determined the level of territorial disaggregation, we must address the issue of available information. Accordingly, we should point out that the Valencian Institute of Economic Research (IVIE) has a long tradition of estimating the values of the HDI for Spanish regions and provinces[1]. We can cite the works of HERRRERO et al., 2010a, HERRRERO et al., 2010b, and HERRRERO et al., 2010c, in this regard. However, their data are only available until 2010 for the Spanish regions and until 2007 for the Spanish provinces. Given that our objective is to assess the influence of the crisis on the convergence process, it is necessary to update the HDI values in order to have a post-crisis interval that is large enough so as to be able to observe the changes in the convergence trajectories. For this reason, the HDI has been obtained for the different Spanish provinces from 1980 to 2014. Nevertheless, given that provincial statistics do not have the level of detail that regional statistics provide, we have had to make small modifications in the definitions of the partial indexes that comprise the HDI. More specifically, we have just considered the value of the *MYSI* in order to obtain the *EI*, given that the *EYS* data are not available by province. Likewise, and for the same reasons, instead of using the GNI, we have used the provincial GDP, using the corresponding CPI as deflator.

Lastly, it is important to note that, in order to be able to compare the results with previous convergence works, we have included the real per capita GDP data in the study, which allows us to analyze the convergence process from different perspectives.

2. 1. Descriptive analysis

The values for the Spanish provinces cover the 1980-2014 period and the data source is reflected in Appendix A. We should recall at this point that Spain is divided into 50 provinces grouped in 17 regions. Additionally, there are two autonomous cities (Ceuta and Melilla), but we have preferred to omit them from the study due to their small dimensions and administrative peculiarities. Thus, we will base the study on the abovementioned 50 provinces. A detailed list of these provinces is displayed in the Appendix B.

First of all, Table 1 presents the initial and final values of the two measurements we are going to use, the per capita GDP and the HDI, as well as its growth rate for the periods 1980-2007, 2007-2014 and 1980-2014. As we can observe, those provinces with lower initial values are those that also have lower final values. To support this statement, it is sufficient to take into account that the Spearman's rank correlation coefficient takes the value of 0.91 when the 1980 and 2007 levels of HDI are compared, and of 0.92 when the values of 1980 and 2014 are analyzed. For the per capita GDP the results are similar: 0.92 and 0.94 for the two cases cited. Therefore, it seems clear that the provinces that are situated in a lower position at the beginning of the sample have not improved significantly with respect to the leaders. Nevertheless, a simple analysis of the growth rates of the different provinces permits us to observe that those provinces with small initial values have grown more, in general, than those with larger values. Furthermore, this is valid for the HDI data as well as the per capita GDP data.

Another interesting way to analyze the data is in terms of the typology of the province. In accordance with the OECD, the TL3 regions, provinces in the Spanish case, are classified into Predominantly Urban (PU), Intermediate (INT), Predominantly Rural Close to a city (PRC) and Predominantly Rural Remote (PRR) to take into account geographical differences among them. This classification is based on population density criteria and on the size of the urban centers located within a region. Table 2 shows the average growth rates of this type of

province for the three periods in which we have divided the sample. The first result we should point out is that the behavior of the PU provinces is similar to that of the INT. There are no great differences in the growth rates of these provinces. If we take the per capita GDP as a reference, we see that both have a growth rate of over 2.6% until 2007, while the crisis has had a remarkable effect on them, decreasing to an annual rate of -2.9%. Something similar occurs when we use the HDI, although in this case the growth rates up to 2007 are much more modest, less than 1%, and over the period of 2008-2014 the growth rate is practically zero without reaching negative numbers.

The behavior of rural provinces describes a slightly different panorama. Using the per capita GDP, we see that the rural provinces grow more than the rest, especially the PRR that exceed a growth rate of 3. This growth slows abruptly in the following period; these rural provinces show a growth rate inferior to the rest of the provinces, once again especially the PRR. We can say something similar when we use the HDI. There are no great differences in the growth of this indicator until 2007, even though the PRR show a slightly higher rate. In the period following the crisis, the growth rate of the rural provinces is the same as those for the urban provinces. In addition, it must be pointed out that the PRR have a lower growth rate (0.22%) than the PRC (0.28%).

This descriptive analysis leads us to reach several conclusions. The first is that there doesn't seem to be a clear convergence pattern between the Spanish provinces, in part due to the great distance between them at the beginning of the sample. Therefore, this result gives rise to the presence of differentiated behavior clubs, which would confirm that of MONTAÑÉS and OLMOS, 2014, in the sense that the evolution of the Spanish economy is more the sum of regional divergent processes than the consequence of convergence between the regions. On the other hand, it does not seem that the crisis has affected the different provinces very unevenly. Moreover, in contrast to what is found in DIJKSTRA et al., 2015, the urban provinces show better growth rates of the per capita GDP in the period from 2008-2014 and very similar values with respect to the HDI.

In any case, these conclusions have been obtained from a simple descriptive analysis of the data. Therefore, it seems to be adequate to use more appropriate techniques to verify whether the crisis unleashed in 2007 has had some kind of effect on the convergence process, a question that will be addressed in the following section.

3. Testing for convergence: Methodology and results

This section first discusses the methodology that we have employed for determining the presence of convergence. Most previous convergence analyses of the variable X over an objective value X^* have been traditionally based on the study of the presence of a unit root in the ratio $\ln(X_{it}/X^*)$, with $i=1,2,\ldots,N$ and $t=1,2,\ldots,T$ reflecting the cross section and sample size of the database, respectively. However, we will employ the methodology recently proposed in PHILLIPS and SUL, 2007, given that it offers some advantages with respect to the standard unit-root based analysis. Furthermore, these authors develop a method for detecting the existence of convergence clubs, a quite feasible hypothesis according to the results of the previous section. Afterwards, we will report the outcomes that we have obtained.

3.1. Methodology

We have followed the recent papers of PHILLIPS and SUL, 2007, and PHILLIPS and SUL, 2009, PS hereinafter, where they develop a very interesting framework to, first, test for the convergence hypothesis and, if this is rejected, to analyze the existence of clubs of regions that show similar patterns of behavior.

Following these authors, let us consider that X_{it} represents the variable of interest (in the present case, the HDI or the per capita GDP) with i=1, 2,…, 50 and t= 1980,…, 2014. This variable can be decomposed as $X_{it} = \delta_{it}\mu_t$, where μ_t is a common component and δ_{it} is the

idiosyncratic one. PS suggest testing for convergence by analyzing whether δ_{it} converges towards δ. To do so, they first define the relative transition component:

$$h_{it} = \frac{X_{it}}{N^{-1} \sum_{i=1}^{N} X_{it}} = \frac{\delta_{it}}{N^{-1} \sum_{i=1}^{N} \delta_{it}} \quad (7)$$

In the presence of convergence, h_{it} should converge towards unity, whilst its cross-sectional variation (H_{it}) should go to 0 when *T* moves toward infinity,

$$H_{it} = N^{-1} \sum_{i=1}^{N} (h_{it} - 1)^2 \to 0 \quad as \quad T \to \infty \quad (8)$$

PS test for convergence by estimating the following equation:

$$log \frac{H_1}{H_t} - 2log[\log(t)] = \alpha + \beta \log(t) + u_t, \; t = [rT] + 1, \dots, T \quad (9)$$

where r takes values around a 1/3 of the sample, following the results of PS. Equation (9) is commonly known as the *log-t* regression. The presence of convergence is tested by way of a standard *t*-statistic and, according to PS, the null hypothesis is rejected whenever this *t*-statistic takes values lower than -1.65. If we reject convergence, we can use the PS algorithm to consider the existence of clubs[2].

3.2. Results

In Panel A of Tables 3 and 4, we present the results of the PS statistic to test for the convergence hypothesis for the HDI and the per capita GDP, both for the total of the available sample and for the period prior to the arrival of the crisis. As one can ascertain, the PS statistic rejects the convergence hypothesis for both variables and for the two samples used. Hence, there does not seem to be great changes from this perspective and one could reach the conclusion that the crisis did not affect the convergence process. However, we must take into account that the convergence statistic is much closer to its critical value when we use the total sample. Thus, it is possible that the crisis could have had some kind of effect, which makes it

necessary to study the existence of convergence clubs and to analyze them to see if they have been modified from 2008 onwards.

The information presented on Panels B and C from Table 3 informs us of the presence of two differentiated clubs in the evolution of the HDI until the year 2007. Both are shown in Figure 1(a). Club 1 is comprised of 30 provinces; therefore, the remaining 20 are assigned to the second group. If we expand the sample to the year 2014, the results change significantly, as can be seen on Table 3 and in Figure 1(b). Now there are only 20 provinces that belong to Club 1, while the remaining 30 are part of Club 2.

In order to better understand the behavior of both clubs, we have calculated an index for each one, taking the average value of the HDI for each province in Clubs 1 and 2 when the entire available sample is used. Figure 2 shows its behavior. We can observe that Club 1 is characterized by having, on average, a higher level of HDI throughout the entire sample. With regard to the evolution, both clubs maintain an increasing pattern that is only broken in 2012, a year in which the growth is negative. But the growth rate is not constant over time. Thus, the index for Club 1 shows an average growth of 0.79% until 2007 and 0.25% after that period. The values of Club 2 are very similar (0.77% and 0.26% respectively). Thus, we can conclude that the distance between both clubs has increased since the second half of the 1990s until the beginning of the crisis. The behavior since 2007 is somewhat different. It is true that the distance between the two groups has stopped increasing, it has even decreased slightly. Nevertheless, we can observe that the distance between the two indexes increases at the end of the sample, which could announce a new increase of the divergence as the leading group economies recover.

With regard to the geographic distribution of the clubs, it does not follow a specific pattern. If we consider the composition of the clubs until 2007, the different regions include provinces in both Club 1 and Club 2, with the exception of the País Vasco and the Comunidad Valenciana, where all their provinces are in Club 1. For the analysis of the entire sample, once again there

is no clear geographic pattern and the regions combine provinces which are in both groups, with the abovementioned exceptions, to which must be added the case of the Islas Canarias, where all of its provinces are in Club 2. Noteworthy is the fact that GIR is the only province of Cataluña that is included in Club 1, clearly showing that the crisis has had a negative effect on this important part of the Spanish economy. Likewise, it is worth pointing out the limited pull of Madrid, given it is surrounded by provinces that belong to Club 2. In spite of the great importance of this province, it is not able to generate enough positive synergies in these provinces other than serving as commuters. Lastly, point out that those provinces that include the capital of the region are largely included in Club 1, with the exception of Cataluña and the Islas Canarias.

To verify whether the composition of both clubs varies for the two samples being considered, we have calculated the statistics of van der Waarden and of Kruskal-Wallis, assigning the value i to Club i-ith (i=1,2,…). These two statistics have the same value, 3.96, and reject that the average distribution of the results for both samples is equal. Therefore, we can state that there is statistical evidence that the convergence in terms of HDI has been affected by the advent of the crisis.

The analysis of the convergence in terms of per capita GDP is shown on Table 4 and in Figure 3. The results allow us to reject the convergence hypothesis for the two considered samples. But, as it occurs with the HDI, we analyze the possible existence of convergence clubs for both time periods. These results are reflected in Panel B of Table 4. If we take the sample until 2007, we observe the existence of three highly differentiated clubs with 20, 26 and 4 provinces in each one. The first group mainly includes most of the northeastern peninsular provinces (see Figure 3 (a)) plus the island provinces of SCT and BAL, a unique province of Castilla y León (SAL) and three provinces in the south (BAD, MAL and ALM). Club 2 includes the provinces located in the northwest of the peninsula, in the center of the country, the east and the extreme south. In Club 3 we have a province from the north of Spain (LUG) and three from the south (CAC, COR and JAE).

If we expand the sample to 2014, the results change notably. Now we only have two clubs. The first is comprised of the provinces from the País Vasco plus Madrid, while the second is made up of the rest of the provinces. If we obtain the statistics from van der Waarden and Krukal-Wallis, they take the values of 4.73 and 7.36, respectively. Therefore the hypothesis that both distributions are equal is rejected and, again, we have clear evidence that the crisis has changed the composition of the clubs.

To better understand the behavior of the clubs and their trajectories throughout the available sample, we have calculated an index that reflects the average value of the per capita GDP for each one of the clubs. Figure 4 shows its evolution. As we can see, both indices show continuous growth until 2007, after which they decrease by approximately the same rate, slightly lower than 19%. Their trajectory runs parallel for many years and the distance hardly varies in absolute terms, being around 6,000 € until the middle of the 1990s. After this period, the distance increases up to 11,000 € in 2008. This year marks a point of no return and the difference decreases to under 9,000 € in 2014, the lowest value since the year 2000. Therefore, we see that the crisis has reduced the distance between the two groups, though it seems to be due more to the negative effect that it had on per capita GDP than to the efforts of the provinces included in Club 2 to reach those of Club 1, as would have been desired.

3.3. Has the crisis especially affected urban provinces?

Once we have presented evidence that the crisis has affected the convergence process among the Spanish provinces, the second question is whether there is a different behavior depending on the degree of urbanization of the provinces, as DJISTRA et al., 2015, shows for the European case.

First of all, taking the HDI data, we see that for the 1980-2007 period, Club 1 is comprised of: 9 PU, 17 INT, 2 PRC and 2 PRR. Therefore, it turns out that the urban provinces are largely

included in this club, with the only exception of SCT. The same occurs with the INT provinces, with the exception of four provinces of Andalucía (ALM, COR, GRA y HUE) and two located in the north of Spain (AST and LEO). In contrast, two PRC (ALB and SOR) and two PRR (BAD and OUR) are included in Club 1.

When the sample is extended to 2014, we have seen that the number of provinces in Club 1 decrease. But this effect does not severely impact urban provinces, so only the following disappear from Club 1: three PU (BAR, MAL and PGC) and six provinces INT (BUR, CAD, GUA, MUR, CAN and TAR), although a new one enters (HSC). Likewise, of the four rural provinces, only BAD continues and, in addition, another PRC is incorporated (TOL), without a doubt benefitting from the capacity of pull of MAD and for being the capital of the Castilla-La Mancha.

We see that the PU and the INT provinces, which were largely included in Club 1 until 2007, are now evenly divided between both clubs. Similarly, rural provinces are scarcely presented in Club 1 now. If we now take the per capita GDP as a reference, the results change. We see that from 1980-2007, Club 1 is composed of 20 provinces: 7 PU, 9 INT, 3 PRC and 1 PRR. Club 2 is made up of 26 provinces: 3 PU, 13 INT, 4 PRC and 6 PRR. The remaining four provinces are in Club 3: only one province INT, 2 PRC provinces and 1 PRR province. It is worth pointing out that only by 40% of the INT provinces are included in Club 1. By contrast, PU provinces are largely presented in Club 1. Also comment on the relatively high percentage of PRC provinces in this club.

When the sample is extended to 2014, the results are different since only 4 provinces remain in Club 1 (3 URB and 1 INT), while the rest go to Club 2. Once again, it is evident that there is a negative effect and that many of the provinces initially included in Club 1 disappear when considering data after 2007. But it does not seem to be an effect that exclusively applies to PU provinces, but rather it clearly extends to the rest.

In any case, it seems appropriate to carry out a more in-depth analysis to determine whether there are statistically significant differences. To this end, we have proceeded to estimate diverse logit models that help us discern which variables are relevant when explaining the formation of the clubs previously estimated. Therefore, the dependent variable is dichotomous and takes the value 0 if the province belongs to Club 1 and the value 1 if it belongs to Club 2. The potential variables that can help us explain why these clubs are formed are many and cover diverse aspects of the economic and social activity of a province. In part they are limited due to the lack of data. The variables we have used respond to the following characteristics of the provinces:

- Geographical and spatial factors: a possible explanation may come from the existence a geographical factor. In order to capture it, we have considered a climate variable, such is the number of sunny days (*SUN*), as is employed in KIM and ROUS, 2012, in order to explain the evolution of the housing prices in the USA.
- Education: this variable has been found to be a very reliable determinant of the urban and regional growth, as can be seen in GLAESER and SAIZ, 2004, MORETTI, 2004, SHAPIRO, 2006, or GLAESER et al., 2014. To measure education, we have used the average of the percentage of the population with higher studies (*STUD*), as is also employed in CRESPO-CUARESMA et al., 2014, or BARTKOWSKA and RIEDL, 2012.
- Creativity: some recent investigations suggest that economic development is driven in large measure by lifestyle factors, such as tolerance and diversity, urban infrastructure and entertainment, as suggested by the seminal works of HOWKINS, 2001, and FLORIDA, 2004. The papers of MARROCU and PACI, 2012, and MARROCU and PACI, 2013, provide evidence that the creative class combined with a high level education can lead the growth of a particular region or city. Thus, we consider the inclusion of a variable that could capture the creativeness of the Spanish provinces in the model. In the absence of a measure, we have considered the average number of books per capita (*BPC*) published in the province during the period 1990-2007.

- Economic structure: we have employed the percentage of workers of the industrial (*ILF*) and the service sectors (*SLF*).
- Tourism sector: this sector is quite important for the Spanish economy, it represents around 11% of the Spanish GDP. Furthermore, it is considered as a key sector in order to allow the Spanish economy to overcome the great recession, given the recent recovery of the sector. We have employed the average stay of travelers by province (*STAY*).
- Technological Innovation: the relationship between innovation and growth is well known since the very important contribution of MCLAURIN, 1953. More recently, MONTAÑÉS and OLMOS, 2014, have found that the evolution of the R&D expenditure can help to understand the lack of convergence across the Spanish regions. We have used the values of the provincial R&D expenditure (measured by its percentage over the provincial GDP) as a proxy of the provincial innovation (*INNOV*).
- Dummy variables: we have also considered some dummy variables. For those provinces which include the capital of the region (*DCAP*), for those provinces which exhibit an insularity condition (*DISL*), for those provinces that constitute a single-province region (*DSPR*), for those provinces which have a foral[3] condition (*DFUE*) and, finally, a dummy for each province class (*DPU*, *DINT*, *DPR*, *DPRC*, *DPRR*).

When selecting the best estimated models, we have followed a strategy from the general to the specific, eliminating those initial variables from the model that are not significant. The results obtained are shown on Table 5. First of all, we must point out that in the case of HDI the relevant variables are the structure of the economy, in particular the weight of the industrial sector, and the type of province. Consequently, we conclude that those PU provinces with high weight in the industrial sector exhibit a high probability of belonging to Club 1. By contrast, a PRR province shows a low probability of being in this club. When we consider the whole sample, the estimated model hardly varies. Nevertheless, we can see small modifications. For instance, we can see that the *DCAP* variable is now relevant, clearly capturing the influence of the *DPU* variable, given that they are clearly correlated. In this

case, it seems that the services and all activity, not only economic, that surrounds a capital city is a plus over the rest of the provinces that make them more prone to be in the group with the higher HDI values. Similarly, the fact of being a rural province but close to a PU does not have a direct effect on belonging to a specific group, which would bring into question the pull capacity of these urban provinces. Furthermore, if we compare the estimated coefficients, we see that the probability of a PRR province being in Club 2 is greater. This also happens with PU provinces, at least with those that are capitals of a region. Thus, it seems that the crisis has increased even further the behavioral dichotomy between these two types of provinces.

The estimations for the case of per capita GDP are shown on Panel B of Table 5. Before going over these results, we must point out that we have eliminated the provinces included in Club 3[4] to make the comparison of the results easier. We see then that the explanatory variables of the model are different from the ones used in the HDI case, with the exception of the productive structure. On the other hand, it is evident that the type of province does not affect the probability of being included in one group or another. Conversely, it is affected by the greater degree of technological development of the province (*INNOV*), the greater weight of the service sector (*SLF*) and, in the opposite case, if it is an island province. Finally, we should mention we have not included the estimated model for the whole sample give that a single variable, *DFUE*, is able to almost perfectly discriminate between the two groups.

4. Conclusions

In this paper we have studied the convergence process across Spanish provinces, paying special attention to the possible effect the crisis could have had on this process. The results obtained show that the evolution of the Spanish economy is made up more of clearly diverging forces than the sum of the convergent behaviors. In fact, using two different indicators, the per capita GDP and the HDI, show the presence of different convergence clubs.

In addition, we must point out that the crisis has clearly modified the convergence pattern. The composition of the clubs has changed notably, there now remains a smaller number of provinces in those clubs with greater indicator values. More specifically, in the case of the HDI, there are now 40% less in the leading group than before the crisis, while this dropout rate is doubled in the case of the per capita GDP. Therefore, only a smaller group of provinces have been able to keep their predominant position. In contrast, only two provinces have improved their position and only using the HDI.

Not only has the composition of the different clubs changed, but we also observe a clear effect on its average evolution. It is true that the crisis has allowed the disparity between the two clubs to close, especially in the case of the per capita GDP. Since the middle of the 1990s this distance had not ceased to increase, therefore, in some way, the crisis has allowed both groups to move closer. However, the latest data available suggests that the separation could increase over the next few years as the leading provinces recover from the effect of the crisis.

From a geographic perspective, we have not found great differences in the behavior of the provinces. We see that the PU and INT provinces show a similar behavior to the PR provinces when considered together. They do, however, differ in regard to the distance from a city. The PRR have a lower growth rate during the crisis, while the PRC had a slightly lower growth rate than the rest of the provinces. This result is important because the results of DIJKSTRA et al., 2015, referring to the group of European regions, does not seem to be valid for the Spanish case.

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Notes

[1] These data are available at http://www.ivie.es/es/banco/desarrollo_humano.php

[2] See Phillips and Sul (2007, 2009) for a description of the use of this algorithm.

[3] *Fueros* are especial regional laws that provide some fiscal advantages.

[4] We have also considered to join Clubs 2 and 3. These results are not reported given that they are essentially similar to those presented in this paper.

Table 1. Levels and growth. Per capita GDP and HDI.

Province	P.c. GDP 1980	Growth P.c. GDP 1980-2007	Growth P.c. GDP 2007-2014	Growth P.c. GDP 1980-2014	P.c. GDP 2014	HDI 1980	Growth HDI 1980-2007	Growth HDI 2007-2014	Growth HDI 1980-2014	HDI 2014
ALA	24.3	1.9%	-3.1%	0.9%	33.5	0.73	0.7%	0.2%	0.6%	0.90
ALB	9.9	2.7%	-2.3%	1.7%	17.7	0.64	0.8%	0.2%	0.7%	0.82
ALI	13.4	2.1%	-2.9%	1.1%	19.6	0.66	0.8%	0.2%	0.7%	0.84
ALM	9.2	3.8%	-3.4%	2.3%	20.3	0.63	0.9%	0.2%	0.7%	0.82
AST	11.6	2.6%	-3.1%	1.4%	19.2	0.68	0.7%	0.2%	0.6%	0.83
AVI	10.2	2.6%	-3.2%	1.4%	16.8	0.66	0.7%	0.2%	0.6%	0.81
BAD	6.8	3.6%	-3.5%	2.1%	14.3	0.60	1.0%	0.3%	0.8%	0.80
BAR	17.6	2.3%	-2.5%	1.3%	27.7	0.71	0.6%	0.2%	0.6%	0.86
BUR	13.4	2.9%	-2.8%	1.7%	24.6	0.70	0.7%	0.2%	0.6%	0.86
CAC	6.4	3.7%	-2.8%	2.4%	14.7	0.62	0.9%	0.2%	0.7%	0.80
CAD	10.5	2.4%	-3.1%	1.3%	16.5	0.64	0.8%	0.3%	0.7%	0.81
CAN	12.0	2.8%	-3.1%	1.6%	20.5	0.69	0.7%	0.3%	0.6%	0.85
CAS	15.6	2.2%	-2.4%	1.3%	24.4	0.67	0.8%	0.3%	0.7%	0.85
CDR	10.5	2.9%	-3.0%	1.7%	18.6	0.63	0.8%	0.2%	0.7%	0.81
COR	10.2	2.4%	-3.0%	1.3%	16.0	0.64	0.8%	0.2%	0.7%	0.81
CRÑ	12.1	2.5%	-3.0%	1.3%	19.2	0.67	0.8%	0.2%	0.6%	0.84
CUE	10.1	3.0%	-3.3%	1.7%	18.1	0.64	0.7%	0.3%	0.6%	0.80
GIR	18.0	2.5%	-2.9%	1.4%	29.5	0.70	0.7%	0.4%	0.6%	0.86
GRA	8.7	3.0%	-3.4%	1.7%	15.6	0.63	0.8%	0.4%	0.7%	0.82
GUA	12.9	2.7%	-2.7%	1.6%	22.7	0.68	0.7%	0.3%	0.6%	0.85
GUI	17.6	2.5%	-3.2%	1.3%	27.9	0.71	0.7%	0.2%	0.6%	0.88
HLV	11.1	2.3%	-2.7%	1.3%	17.5	0.63	0.8%	0.2%	0.7%	0.81
HSC	14.1	2.7%	-3.0%	1.5%	24.0	0.68	0.7%	0.3%	0.6%	0.84
BAL	13.2	3.2%	-2.3%	2.0%	26.7	0.67	0.8%	0.3%	0.7%	0.85
JAE	9.0	2.6%	-2.5%	1.6%	15.5	0.62	0.8%	0.3%	0.7%	0.80
LEO	10.3	2.9%	-2.9%	1.7%	18.5	0.67	0.7%	0.2%	0.6%	0.82
LLE	16.4	2.6%	-2.7%	1.5%	27.7	0.68	0.7%	0.5%	0.6%	0.85
LUG	10.0	2.6%	-2.9%	1.5%	16.9	0.64	0.7%	0.4%	0.7%	0.81
MAD	16.3	3.0%	-2.7%	1.8%	30.7	0.72	0.7%	0.2%	0.6%	0.89
MAL	9.7	2.9%	-3.3%	1.7%	17.3	0.64	0.8%	0.3%	0.7%	0.82
MUR	12.4	2.4%	-2.9%	1.3%	19.5	0.66	0.8%	0.3%	0.7%	0.83
NAV	17.8	2.3%	-2.4%	1.3%	28.2	0.71	0.7%	0.2%	0.6%	0.88
OUR	7.3	3.6%	-2.8%	2.3%	16.3	0.61	0.9%	0.4%	0.8%	0.81
PAL	14.2	2.3%	-3.0%	1.3%	22.0	0.68	0.7%	0.1%	0.6%	0.82
PGC	12.9	2.4%	-2.5%	1.4%	20.8	0.66	0.8%	0.2%	0.7%	0.83
PON	10.1	2.9%	-3.3%	1.7%	17.9	0.65	0.8%	0.3%	0.7%	0.83
RIO	16.7	2.1%	-2.5%	1.2%	25.1	0.69	0.7%	0.3%	0.6%	0.86
SAL	8.5	3.4%	-2.9%	2.1%	17.5	0.67	0.7%	0.4%	0.6%	0.84
SEG	11.4	3.1%	-3.2%	1.8%	21.3	0.68	0.7%	0.3%	0.6%	0.84
SEV	10.6	2.8%	-3.1%	1.6%	18.4	0.64	0.9%	0.3%	0.8%	0.83
SOR	12.1	2.8%	-2.2%	1.8%	22.3	0.69	0.7%	0.4%	0.6%	0.85
TAR	17.3	2.6%	-2.6%	1.5%	29.2	0.68	0.7%	0.4%	0.6%	0.85
SCT	11.9	2.7%	-2.9%	1.5%	20.3	0.67	0.7%	0.4%	0.6%	0.83

TER	14.4	2.5%	-3.0%	1.4%	23.2	0.67	0.7%	0.1%	0.6%	0.83
TOL	11.0	2.9%	-3.5%	1.6%	19.3	0.65	0.8%	0.2%	0.7%	0.82
VAL	12.8	2.6%	-3.0%	1.5%	21.6	0.67	0.8%	0.3%	0.7%	0.85
VLD	12.5	2.7%	-2.9%	1.6%	21.5	0.70	0.7%	0.3%	0.6%	0.87
VZC	16.8	2.2%	-2.7%	1.2%	25.6	0.70	0.7%	0.2%	0.6%	0.87
ZAM	7.9	3.2%	-3.1%	1.9%	15.5	0.64	0.7%	0.1%	0.6%	0.78
ZAR	12.8	3.2%	-3.1%	1.9%	24.6	0.69	0.7%	0.1%	0.6%	0.86

This table presents the values for the HDI and the per capita GDP for the Spanish provinces in 1980 and 2014. The growth of these variables for the pre-crisis, the post-crisis and the whole periods is also displayed. The per capita GDP is measured in thousands € (2010 constant Euros). P.c.: per capita.

Table 2. Growth rates for the Spanish provinces. Per capita GDP and HDI.

	Panel A. Per capita GDP			Panel B. HDI		
	1980-2007	2008-2014	1980-2014	1980-2007	2008-2014	1980-2014
PU	2.66%	-2.90%	1.52%	0.74%	0.25%	0.64%
INT	2.63%	-2.88%	1.50%	0.74%	0.27%	0.65%
PR	2.91%	-2.95%	1.71%	0.76%	0.25%	0.66%
PRC	2.81%	-2.88%	1.64%	0.76%	0.29%	0.66%
PRR	3.04%	-3.03%	1.79%	0.76%	0.22%	0.65%

This table presents the average growth rates for the different periods of the OECD TL3 Spanish provinces. PU: Predominantly Urban; INT: Intermediate; PR: Predominantly Rural; PRC: Predominantly Rural close to a City; PRR: Predominantly Remote Rural. Panel A refers to the per capita GDP and Panel B to the HDI.

Table 3. PS methodology. HDI.

Panel A. Testing for convergence	
1980-2007	1980-2014
-0.289 (-16.989)	-0.186 (-9.888)
Panel B. Estimated Clubs	
1980-2007	1980-2014
Club 1 ALA BAD CAS MAD	*Club 1* ALA BAD CRÑ GUI MAD
Club 2 ALI BAL CRÑ GIR GUI NAV SEV	*Club 2* ALI BAL CAS GIR HUE RIO NAV PON SAL SEV TOL VAL VLD VZC ZAR
Club 3 ALB BAR BUR CAD GUA RIO MAL MUR OUR PGC PON SAL CAN SOR TAR VAL VLD VZC ZAR	*Club 3* ALB ALM AVI BAR BUR CAC CAD CDR COR CUE GRA GUA HSC JAE LEO LLE LUG MAL MUR OUR AST PAL PGC SCT CAN SEG SOR TAR TER ZAM
Club 4 ALM AVI CAC CDR COR CUE GRA HLV HSC JAE LEO LLE LUG AST PAL SCT SEG TER TOL	
Panel C. Testing for adjacent clubs	
1980-2007	1980-2014
Clubs 1+2 0.111 (2.465)	*Clubs 1+2* 0.078 (2.091)
Clubs 1+2+3 0.041 (0.962)	*Clubs 1+2 +3* -0.186 (-9.888)
Clubs 1+2+3+4 -0.289 (-16.989)	

This table presents the results of applying the Phillips and Sul methodology to the HDI. First, Panel A shows the estimation results of the equation (9). Panel B displays the members of each club and Panel C presents the results of testing for adjacent clubs. t-ratios in parentheses.

Table 4. PS methodology. Per capita GDP.

Panel A. Testing for convergence	
2007	2014
-0.218 (-12.407)	-0.135 (-6.329)
Panel B. Estimated Clubs	
2007	2014
Club 1 ALA ALM BAD GIR GUI LLE MAD TAR	*Club 1* ALA GUI MAD VZC
Club 2 BAL BAR BUR HSC MAL NAV SAL SCT SAN SEG VZC ZAR	*Club 2* ALB ALI ALM AVI BAD PMA BAR BUR CAC CAD CAS CDR COR CRÑ CUE GIR GRA GUA HUE HSC JAE LEO LLE RIO LUG MAL MUR PAM OUR AST PAL PGC PON SAL SCT SAN SEG SEV SOR TAR TER TOL VAL VLD ZAM ZAR
Club 3 ALB ALI AVI CAD CAS CDR CUE GRA RIO OUR PAL PGC PON SEV TER VAL VLD ZAM	
Club 4 CRÑ GUA HUE LEO MUR AST SOR TOL	
Club 5 CAC COR JAE LUG	
Panel C. Testing for adjacent clubs	
2007	2014
Clubs 1+2 0.082 (2.672)	
Clubs 1+2+3 -0.078 (-3.555)	
Clubs 3+4 0.176 (4.182)	
Clubs 3+4+5 -0.050 (-2.085)	

This table presents the results of applying the Phillips and Sul methodology to the per capita GDP. First, Panel A shows the estimation results of the equation (9). Panel B displays the members of each club and Panel C presents the results of testing for adjacent clubs. t-ratios in parentheses.

Table 5. Estimation of the logit model. HDI and per capita GDP.

Panel A. HDI			Panel B. Per capita GDP	
Variables	1980-2007	1980-2014	Variables	1980-2007
ILF	-0.19	-0.14	*SLF*	-0.19
	(-3.18)	(-2.06)		(-2.61)
DPRR	1.70	2.26	*INNOV*	-8.89
	(1.65)	(2.40)		(-3.92)
DPU	-2.36		*DISL*	3.91
	(-2.10)			(2.00)
DCAP		-3.19		
		(-2.07)		
Intercept	3.19	3.32	*Intercept*	15.56
	(2.65)	(2.38)		(3.42)
R^2	0.32	0.36	R^2	0.31
Correct Class.	74%	88%	Correct Class.	76%

This table presents the coefficient estimates of the logit model. t-ratios in parentheses. Panel A refers to the HDI for the periods 1980-2007 and 1980-2014, and Panel B for the per capita GDP for the period 1980-2007.

Figure 1. Estimated clubs. HDI

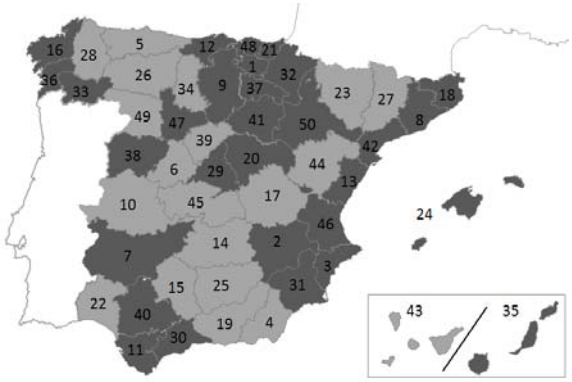


Figure 1(a). HDI 2007

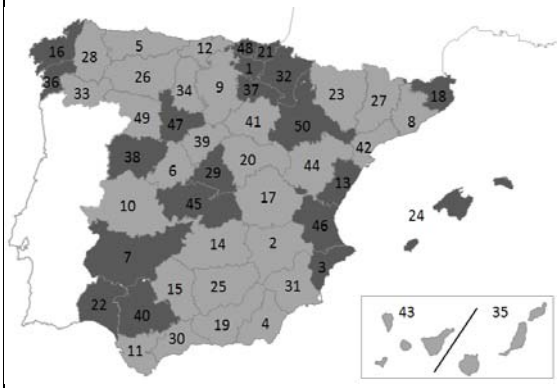
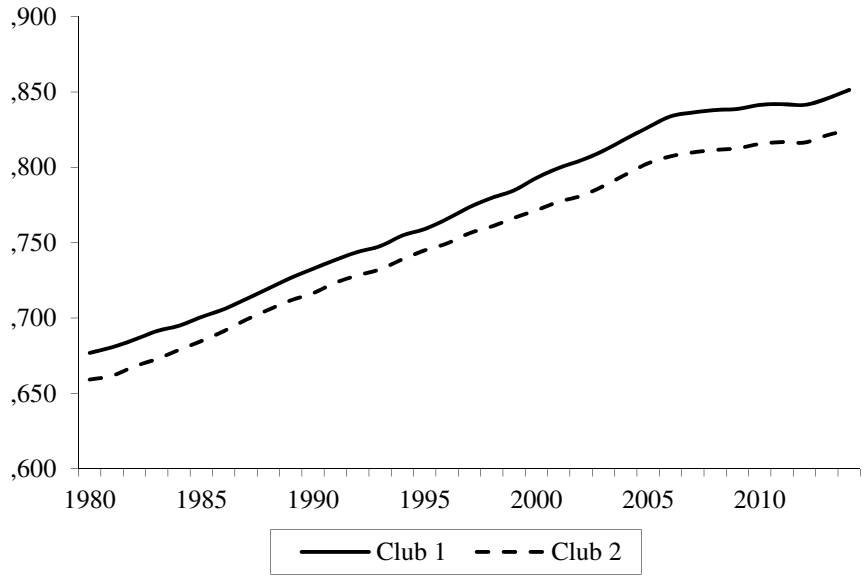


Figure 1(b). HDI 2014

Club 1 Club 2

This figure presents the final classification of the Spanish provinces for the HDI into the estimated Clubs 1 and 2. Figure 1(a) considers the sample 1980-2007 and Figure 1(b) the sample 1980-2014.

Figure 2. Average values of the provinces in Clubs 1 and 2.. HDI



This figure presents the evolution for the average HDI of Clubs 1 and 2 when the 1980-2014 sample is considered.

Figure 3. Estimated clubs. GDP

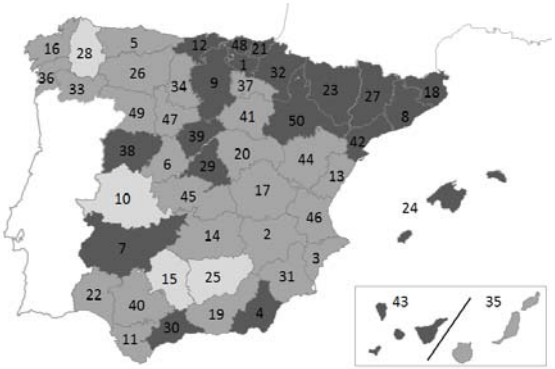


Figure 3(a). GDP 2007

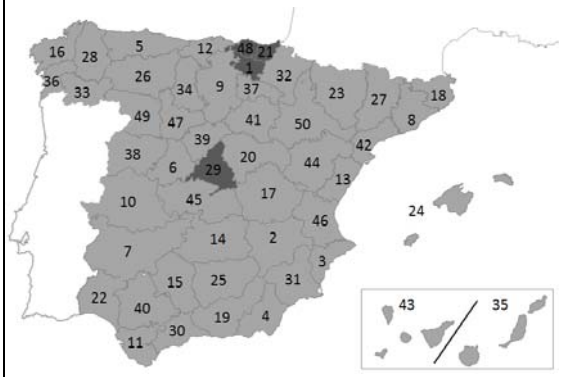
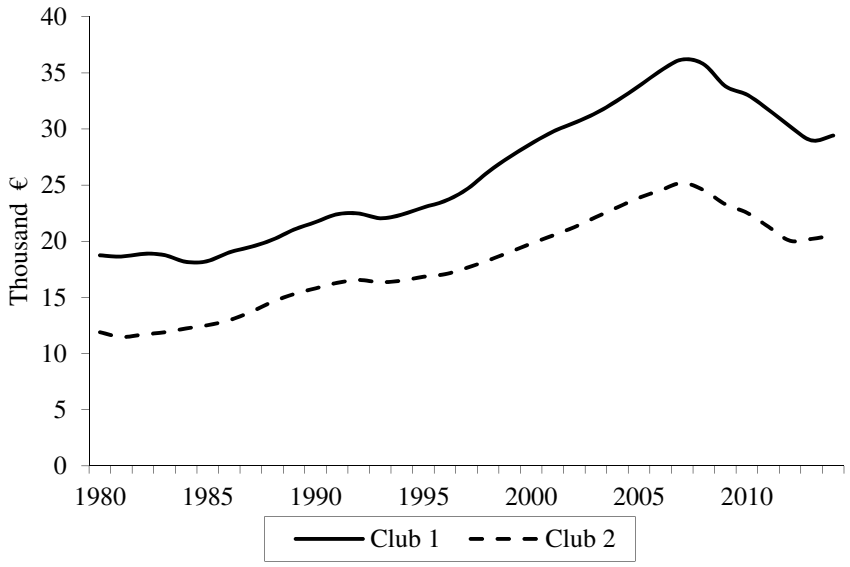


Figure 3(b). GDP 2014

Club 1 Club 2 Club 3

This figure presents the final classification of the Spanish provinces for the per capita GDP into the estimated Clubs 1, 2 and 3. Figure 1(a) considers the sample 1980-2007 and Figure 1(b) the sample 1980-2014.

Figure 4. Average values of the provinces in Clubs 1 and 2. Per capita GDP



This figure presents the evolution for the average per capita GDP of Clubs 1 and 2 when the 1980-2014 sample is considered.

Appendix A

The data have been obtained from the following sources:

- Per capita GDP: In order to obtain this variable, we have first joined the different database of the provincial GDP, available at the web page of the Spanish Institute of Statistics (INE) (www.ine.es). We have transformed in real terms by using the annual average of the consumer price index and, finally, we have divided by the population of the corresponding provinces. Population and consumer price index are also available at the abovementioned web page. The values of the nominal GDP for the 2013-2014 period have been predicted by using the Spanish nominal GDP.
- Mean Year of Schooling: These data are available at the IVIE web page (http://www.ivie.es/es/banco/caphum/series.php) for the 1980-2013 sample. The data for 2014 have been predicted by using the evolution of the percentage of population with tertiary studies in Spain.
- Life expectancy at birth: These data have been obtained from the INE web page.

Appendix B

Table B1. List of provinces

Nº	Province	Acronym	Region	Class	Other characteristics
1	Álava	ALA	País Vasco	INT	Foral
2	Albacete	ALB	Castilla-La Mancha	PRC	
3	Alicante	ALI	Comunidad Valenciana	INT	
4	Almería	ALM	Andalucía	INT	
5	Asturias	AST	Principado de Asturias	INT	Uniprovincial
6	Ávila	AVI	Castilla y León	PRR	
7	Badajoz	BAD	Extremadura	PRR	
8	Barcelona	BAR	Cataluña	PU	
9	Burgos	BUR	Castilla y León	INT	
10	Cáceres	CAC	Extremadura	PRR	
11	Cádiz	CAD	Andalucía	INT	
12	Cantabria	CAN	Cantabria	INT	Uniprovincial
13	Castellón	CAS	Comunidad Valenciana	INT	
14	Ciudad real	CDR	Castilla-La Mancha	PRR	
15	Córdoba	COR	Andalucía	INT	
16	Coruña, A	CRÑ	Galicia	INT	
17	Cuenca	CUE	Castilla-La Mancha	PRR	
18	Girona	GIR	Cataluña	INT	
19	Granada	GRA	Andalucía	INT	
20	Guadalajara	GUA	Castilla-La Mancha	INT	
21	Guipúzcoa	GUI	País Vasco	PU	Foral
22	Huelva	HLV	Andalucía	INT	
23	Huesca	HSC	Aragón	PRC	
24	Illes Balears	BAL	Illes Balears	INT	Uniprovincial, insular
25	Jaén	JAE	Andalucía	PRC	
26	León	LEO	Castilla y León	INT	
27	Lleida	LLE	Cataluña	PRC	
28	Lugo	LUG	Galicia	PRC	
29	Madrid	MAD	Comunidad de Madrid	PU	Uniprovincial
30	Málaga	MAL	Andalucía	PU	
31	Murcia	MUR	Región de Murcia	INT	Uniprovincial
32	Navarra	NAV	Comunidad Foral de Navarra	INT	Foral, Uniprovincial
33	Ourense	OUR	Galicia	PRC	
34	Palencia	PAL	Castilla y León	PRC	
35	Palmas, Las	PGC	Canarias	PU	Insular
36	Pontevedra	PON	Galicia	INT	
37	Rioja, La	RIO	La Rioja	INT	Uniprovincial
38	Salamanca	SAL	Castilla y León	INT	
39	Segovia	SEG	Castilla y León	PRC	
40	Sevilla	SEV	Andalucía	PU	
41	Soria	SOR	Castilla y León	PRR	
42	Tarragona	TAR	Cataluña	INT	

43	Santa Cruz de Tenerife	SCT	Canarias	PU	Insular
44	Teruel	TER	Aragón	PRR	
45	Toledo	TOL	Castilla-La Mancha	PRC	
46	Valencia	VAL	Comunidad Valenciana	PU	
47	Valladolid	VLD	Castilla y León	INT	
48	Vizcaya	VZC	País Vasco	PU	Foral
49	Zamora	ZAM	Castilla y León	PRR	
50	Zaragoza	ZAR	Aragón	PU	