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Miguel Viegas and Micaela Antunes

Convergence in the Spanish and Portuguese NUTS 3 Regions: An Exploratory Spatial Approach

Since their accession to the European Union in 1986, both Portugal and Spain have benefited from strong financial support. Both countries have experienced considerable growth in income per capita, converging towards average European levels. However, several studies suggest a high degree of persistence of regional asymmetries within the countries. This paper empirically analyses convergence among NUTS 3 regions of the Iberian Peninsula between 1995 and 2008. The results reveal divergent national trends and indicate no evidence of catching-up effects among the poorest regions, confirming the existence of economic clusters.

Over the last several decades, economies have been experiencing mixed performances regarding economic growth, thus motivating economists to study convergence. While some economies have been improving their income levels, others have become progressively poorer on a worldwide scale, thus widening income gaps and deepening disparities.

Despite the large literature dealing with the topics of economic growth and convergence, we emphasise the neoclassical perspective following Solow's long-run growth model.[1] According to that formulation, countries with an initially lower capital stock grow faster than others at an earlier stage before converging to grow at similar rates in the long term. The explanation lies in the decreasing marginal returns to capital, implying that the lower the stock of capital, the higher the corresponding marginal productivity.

Therefore, the further an economy is from a steady state, the faster the rate of growth. However, the rate declines when the economy moves from a low per capita income level to a higher one. At the end of the transitional dynamics, the initially poorer economy reaches the per capita income level of the richer economy (*catching up*). According to this view, divergence is a transitory short-term phenomenon reflecting adjustments towards a long-run equilibrium level of per capita income. This basic kind of convergence to a common income level, showing an inverse relationship between the initial income level and the corresponding growth rate, is known as absolute (or unconditional) beta convergence, a term first applied in the early 1990s.[2] Absolute convergence is a strong assumption, as it implies that economies possess the same structural parameters (saving rate, population growth, capital depreciation and technology level), differing only in terms of capital endowment. Therefore, it is more probable that such a condition is met for a group of homogenous economies with common institutional and legal features and similar economic parameters. As similarities in terms of common economic policies as well as the higher mobility of factors of production and technological diffusion are more common within national boundaries, it is expected that regions of a given country tend to converge to a certain steady state.[3]

Our focus is specifically on regions of the Iberian Peninsula. The first reason is geographical: Portugal and Spain share a common border. Moreover, these countries have been historically engaged, becoming increasingly integrated throughout the years and having entered the European Economic Community (EEC) in the same year. The countries differed in their structural indicators, but both managed to fulfil the nominal targets and be among the 11 initial countries to enter the third stage of the Economic and Monetary Union (EMU).

1 R. Solow: A contribution to the theory of economic growth, in: Quarterly Journal of Economics, Vol. 70, No. 1, 1956, pp. 65-94.

2 R. Barro, X. Sala-i-Martin: Economic growth, Cambridge 2004, The MIT Press.

3 X. Sala-i-Martin: Regional cohesion: evidence and theories of regional growth and convergence, in: European Economic Review, Vol. 40, No. 6, pp. 1325-1352.

Miguel Viegas, University of Aveiro, Portugal.

Micaela Antunes, University of Coimbra, Portugal.

Since their accession to the EU, both Portugal and Spain have experienced considerable economic growth and convergence towards the EU average GDP per capita. In general terms, Spain has had better economic performance than Portugal since adhesion, both at the national and the regional level. Several improvements have been achieved in both countries, particularly in infrastructure, accompanied by increased public investment. However, regional disparities have persisted; indeed, regional gaps have increased in many cases.[4] By the time of the adhesion to the EEC, most Portuguese and Spanish regions were Objective 1 regions, meaning that their per capita GDP was less than 75% of the Community average, and thus they were eligible to receive Structural Funds from the EU in order to catch up with the richer nations. As such, Portugal and Spain have benefited extensively from EU assistance funds. During the period between 1995 and 2008, Portugal and Spain together received about €140 billion (at current prices, including Structural and Cohesion Funds) through the Delors II Package (1994-1999) and the Agenda 2000 (2000-2006).

This monetary support has been at the core of a wide debate on the efficiency of Structural Funds, as it was mostly oriented towards infrastructure and thus did not result in convergence but rather in the concentration of technologically advanced activities in specific points in space.[5] Qualification of the workforce and human capital improvement were not a real priority. Moreover, since the entry of Eastern European countries to the EU, it is interesting to observe how these two main receivers of funds deal with the challenge of smaller allocations of financial resources.

Several empirical studies on regional convergence have pointed to a significant regional convergence process in Spain until the late 1970s and in Portugal from the 1980s until the mid-1990s.[6] Unfortunately, empirical evidence is not conclusive concerning recent decades. Sanchez and Roura[7] state that regional disparities have remained essentially constant, while Marelli[8] finds a slowing, although positive, cross-regional convergence process between 1990 and 2005. Rodriguez-Pose,[9] Rodriguez-Pose and Fratesi,[10] and Costa and Fonseca[11] analyse the regional disparities since 1989 and find considerable growth in the standard deviation of both Portuguese and Spanish regions at the NUTS 2 level.[12]

Therefore, considering the spatial continuity of Spain and Portugal, together with their similar historical paths concerning EEC entry, we proceed with an empirical convergence exercise among the NUTS 3 regions of the Iberian Peninsula, using a spatial econometric approach as a means to embody the role of space and geography. Regional economies tend to be more open and more specialised than national ones. As spatial units become smaller, economic specialisation increases and spatial dependence becomes more relevant. The convergence literature also pays particular attention to the national effect, according to which each region is closely linked to the respective national economic performance.[13] As such, we differentiate between Portuguese and Spanish regions in order to check for the presence of a national convergence club effect.

The analytical framework

The neoclassical growth model is based on Solow's[14] approach and assumes that in the long run all economies converge to the same steady-state level of per capita income, as they grow more rapidly the further the economy is initially from the equilibrium level. Whenever a negative and statistically significant relation is found between the initial per capita GDP level and the corresponding growth rate, we can assume the presence of absolute beta convergence.[15] Absolute beta convergence was investigated by Baumol[16] through the following equation:

$$\frac{1}{T}\ln\frac{y_{i,T}}{y_{i,0}} = \alpha + \beta \ln y_{i,0} + \varepsilon_i \qquad \varepsilon_i \rightarrow i.i.d\,(0, \sigma_\varepsilon^2) \qquad (1)$$

4 E. Costa, M. Fonseca: Convergência económica e coesão social e territorial da Península Ibérica na União Europeia, in: X Colóquio Ibérico de Geografia – A geografia ibérica no contexto europeu, Universidade de Évora 2005.

5 For an interesting survey about structural funds and Objective 1 regions see: F. Torres, M.L. de Freitas, F. Pereira: Convergence among EU Regions, 1990-2001 – Quality of National Institutions and "Objective 1" Status, in: Intereconomics, Vol. 38, No. 5, 2003, pp. 270-275.

6 A. Sanchez, T. Roura: Regional convergence in productivity and productive structure. Application to European Southern countries, in: Institute of Social and Economic Analysis, Working paper, No. 11, 2008.

7 Ibid.

8 E. Marelli: Specialisation and convergence of European regions, in: The European Journal of Comparative Economics, Vol. 4, No. 2, 2007, pp. 149-178.

9 A. Rodriguez-Pose: Economic convergence and regional development strategies in Spain: The case of Galicia and Navarre, in: European Investment Bank Papers, Vol. 5, No. 1, 2000, pp. 89-115.

10 A. Rodriguez-Pose, U. Fratesi: Between development and social policies: the impact of European Structural Funds in Objective 1 regions, in: European Economy Group – Working Paper, No. 28, 2003.

11 E. Costa, M. Fonseca, op. cit.

12 Most of the references about empirical studies use the NUTS 2 regional level.

13 See J. Lopez-Rodriguez, A. Faina: Regional policy and convergence in Europe: the case of backward regions, in: Economics Bulletin, Vol. 29, No. 2, 2009, pp. 1046-1053; and A. Sanchez, T. Roura, op. cit.

14 R. Solow, op. cit.

15 R. Barro, X. Sala-i-Martin, op. cit.

16 W. Baumol: Productivity growth, convergence and welfare: what the long-run data show?, in: American Economic Review, Vol. 76, No. 5, 1986, pp. 1072-1085.

where $y_{i,0}$ and $y_{i,T}$ correspond to the per capita GDP of region i at the initial and final periods respectively and T is the time interval. The left-hand side represents the average annual log growth rate of per capita GDP of region i, α and β are the parameters to be estimated, and ε is the error term. From the estimation of β, we obtain the annual speed of convergence, $\theta = -\frac{\ln(1 + T\beta)}{T}$ and the half-life of convergence, $\tau = \frac{\ln 2}{\theta}$.[17]

Another concept of convergence is that of sigma-convergence, which analyses the evolution of income disparities across economies over time through measures of dispersion like the coefficient of variation (an indicator of relative dispersion given by the ratio of the standard deviation over the sample mean). A reduction in this indicator implies a decrease in dispersion and thus the existence of sigma-convergence. Beta-convergence is a necessary but not sufficient condition for sigma-convergence to occur.[18]

Many convergence studies use cross-section analyses. However, there are several criticisms of these models, mostly related to the existence of multicollinearity, endogeneity bias and the existence of specification errors. These problems may seriously affect the robustness of the convergence coefficient and produce misleading outcomes.[19] Moreover, the introduction of the geographical dimension allows one not only to capture the spatial effect but also to improve the estimation and forecasting, since spatial dependence violates some of the Gauss-Markov assumptions of the OLS estimation (cross-section observations are no longer independent), producing inefficient estimators.[20]

Several studies focusing on the importance of spatial location for growth argue that when spatial correlation is ignored, the results regarding economic growth may be biased. Two kinds of spatial effects are pointed out in the literature: (i) spatial autocorrelation, revealing that contiguous regions may influence each other's performance through spillover effects, and (ii) spatial heterogeneity, whenever the same functional form is erroneously considered for all regions.[21] Spatial autocorrelation can be of two types: spatial autoregressive dependence in the variables due to interrelationships between economic variables of contiguous regions and spatial autocorrelation in the disturbance term, which can be due to omitted variables or deficient functional form.

For our exploratory spatial analysis, we use per capita GDP at the NUTS 3 level between 1995 and 2008, as published by the Portuguese and Spanish national statistics offices, deflated by a national GDP deflator.[22] We only collect information for regions of mainland Portugal and Spain. Regions like the Azores, Madeira and the Canary Islands are excluded from our analysis as they do not have spatial contiguity with other regions (see Table 1). Summing up, our database comprises 75 spatial units, 28 in Portugal and 47 in Spain. After assessing sigma-convergence, we test the presence of spatial autocorrelation in average per capita GDP and in growth rates using the Moran's I autocorrelation coefficient. Finally, we estimate the beta-convergence process. We introduce a national dummy to test the presence of spatial heterogeneity. This specification allows us to estimate the possibility of two different convergence patterns in each country. All estimations are carried out in MATLAB using the general maximum likelihood method.[23]

The exploratory spatial data analysis: results and discussion

Figure 1 illustrates the dispersion, measured by the coefficient of variation of the logarithm of per capita GDP during the 1995-2008 period, in the Portuguese and Spanish regions separately and in all 75 regions combined. In the combined result, the regional dispersion decreases until 2001 and thereafter increases, reaching a higher level of dispersion relative to the initial point. The dispersion across Portuguese regions shows a downward path over the whole period, while the Spanish coefficient of variation increases a little at first and decreases steadily from 1999 onwards to a point below the initial dispersion level. Moreover, the Portuguese regional dispersion is above the Spanish regional dispersion levels throughout the entire period. The apparent contradiction between the overall sigma-divergence process and the two national sigma-convergence process-

17 For details, see N. Islam: Growth empirics: a panel data approach, in: The Quarterly Journal of Economics, Vol. 110, No. 4, 1995, pp. 1127-1170; S. Silva, M. Silva: Crescimento económico nas regiões europeias: Uma avaliação sobre a persistência das disparidades regionais no período 1980-95, in: FEP Working Paper, No. 96, 2000.

18 M. Chatterji: Convergence clubs and endogenous growth, in: Oxford Review of Economic Policy, Vol. 8, No. 4, 1992, pp. 57-69.

19 See D. Quah: Galton's fallacy and tests of the convergence hypothesis, in: The Scandinavian Journal of Economics, Vol. 95, No. 4, 1993, pp. 427-443; P. Evans: Using cross-country variances to evaluate growth theories, in: Journal of Economic Dynamics and Control, Vol. 20, No. 6-7, 1996, pp. 1027-1049; and F. Caselli, G. Esquivel, F. Lefort: Reopening the convergence debate: a new look at cross-country growth empirics, in: Journal of Economic Growth, Vol. 1, No. 3, 1996, pp. 363-389.

20 See, among others, L. Anselin: Spatial econometrics: methods and models, Dordrecht 1988, Kluwer Academic Publishers; J. LeSage, R. Pace: Introduction to spatial econometrics, USA 2009, CRC Press, Taylor and Francis Group.

21 For comprehensive references on spatial econometrics see for instance L. Anselin, op. cit.; J. LeSage, R. Pace, op. cit; J. LeGallo: Econometrie spatiale: l'autocorrelation spatial dans les modèles de regression lineaire, in: Economie et Provision, Vol. 155, No. 4, 2002, pp.139-158.

22 AMECO database.

23 We use the LeSage Spatial Econometrics Toolbox functions available at http://www.econ.utoledo.edu.

Table 1
Iberian Peninsula regions (NUTS 3)

CODE	NUTS 3	CODE	NUTS 3	CODE	NUTS 3	CODE	NUTS 3
ES243	Zaragoza	ES412	Burgos	ES617	Málaga	PT161	Baixo Vouga
ES242	Teruel	ES418	Valladolid	ES612	Cádiz	PT168	Beira Interior Norte
ES241	Huesca	ES411	Ávila	ES615	Huelva	PT166	Pinhal Interior Sul
ES230	La Rioja	ES419	Zamora	ES618	Sevilla	PT163	Pinhal Litoral
ES220	Navarra	ES416	Segovia	ES614	Granada	PT16C	Médio Tejo
ES212	Guipúzcoa	ES432	Cáceres	ES611	Almería	PT16B	Oeste
ES213	Vizcaya	ES431	Badajoz	ES613	Córdoba	PT162	Baixo Mondego
ES211	Álava	ES424	Guadalajara	ES616	Jaén	PT164	Pinhal Interior Norte
ES300	Madrid	ES423	Cuenca	ES620	Murcia	PT16A	Cova da Beira
ES120	Astúrias	ES422	Ciudad Real	PT184	Baixo Alentejo	PT169	Beira Interior Sul
ES130	Cantabria	ES421	Albacete	PT182	Alto Alentejo	PT114	Grande Porto
ES112	Lugo	ES425	Toledo	PT183	Alentejo Central	PT117	Douro
ES114	Pontevedra	ES514	Tarragona	PT185	Lezíria do Tejo	PT111	Minho-Lima
ES111	A Coruña	ES513	Lleida	PT181	Alentejo Litoral	PT118	Alto Trás-os-Montes
ES113	Ourense	ES512	Girona	PT150	Algarve	PT116	Entre Douro e Vouga
ES413	León	ES511	Barcelona	PT171	Grande Lisboa	PT112	Cávado
ES414	Palencia	ES522	Castellón/Castelló	PT172	Península de Setúbal	PT113	Ave
ES417	Soria	ES523	Valencia/València	PT167	Serra da Estrela	PT115	Tâmega
ES415	Salamanca	ES521	Alicante/Alacant	PT165	Dão-Lafões		

Source: Eurostat.

es can be explained by a divergence process between the two countries. In fact, Portuguese per capita GDP represented 65% of the Spanish per capita GDP in 1995, rose to 68% in 1999 and decreased to 54% in 2008.

The spatial autocorrelation is widely measured by Moran's I statistic, which can be represented by the expression:

$$I_t = \frac{n}{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}} \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij} x_{it} x_{jt}}{\sum_{i=1}^{n}\sum_{j=1}^{n} x_{it} x_{jt}} \qquad (2)$$

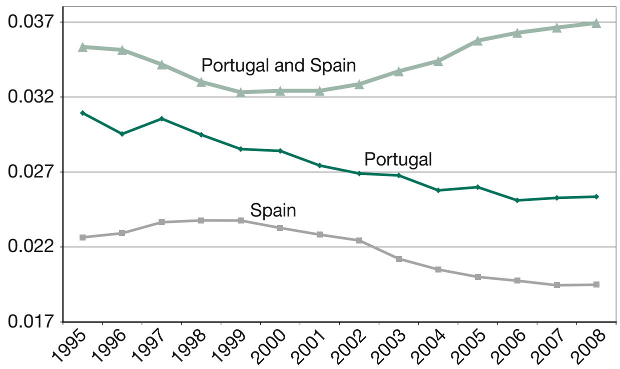
where w_{ij} represents the $\{i, j\}$ element of the spatial contiguity matrix, W, such that $w_{ij} = 1$ if municipalities i and j are neighbours and $w_{ij} = 0$ otherwise; x_{it} represents the logarithm of per capita GDP (in deviation from the mean) of region i at time t; and n is the number of observations.

Moran's I estimates the linear dependence between a variable in a specific location and the mean of the same variable in the neighbourhood. Moran's I statistic and the respective marginal probability relative to the logarithm of per capita GDP are shown in Table 2, revealing a positive and significant spatial dependence in all years and in each scenario (in all regions of the Iberian Peninsula as well as when national regions are separated). This means that richer regions tend to be located near other rich regions, while poor regions tend to be located near other poor regions. Moran's I statistic for all regions (Portuguese and Spanish) shows a similar trend as that for the coefficient of variation, i.e. decreasing initially and increasing from 2000 onwards (the correlation between Moran's I statistic and the coefficient of variation is 0.95). This result points out that spatial dependence increases with spatial dispersion, which may be interpreted as a shadow effect of richer regions over poor ones, leading to a more unequal distribution of economic activity. Regarding Portugal and Spain separately, however, we observe decreasing trends for the whole period, rather similar to the respective coefficients of variation (the correlations are 0.78 and 0.53 respectively). Spain exhibits a stronger pattern of spatial autocorrelation.[24]

Figure 2 presents the distribution of average per capita GDP for the 1995-2008 period across all Iberian regions. The map shows a concentration of rich regions in the northeast of Spain (the Portuguese Grande Lisboa rich

24 The positive correlation between the Moran's I statistic and the coefficient of variation can be found in other empirical studies (see, for instance, J. Le Gallo et al., op.cit.).

Figure 1
Sigma-convergence between 1995 and 2008



Sources: National statistics offices.

region is the exception); a broad area composed of medium-size income regions in the centre, south and north of Spain with some central and southern Portuguese regions; and a poor area composed of the northern and inland Portuguese regions.

Figure 3 presents the LISA cluster map and the Moran scatter plot of the same variable. The Moran scatter plot depicts the variable on the horizontal axis with the average values of the neighbouring regions for the same variable on the vertical axis. The four quadrants in the scatter plot show (i) the regions with high per capita GDP associated with neighbouring regions with high per capita GDP (top-right), (ii) the regions with low per capita GDP associated with neighbouring regions with low per capita GDP (bottom-left), (iii) the regions with low per capita GDP associated with neighbouring regions with high per capita GDP (top-left) and (iv) the regions with high per capita GDP associated with neighbouring regions with low per capita GDP (bottom-right). The first and second quadrants (high-high and low-low) highlight the existence of positive autocorrelation, while the third and fourth ones show negative autocorrelation. Therefore, the presence of a large number of 61 regions (81%) in the first and second quadrants is a clear sign of positive spatial autocorrelation. The remaining 14 regions occupy the atypical locations of quadrants three and four. The LISA cluster map depicts these types of spatial association. The spatial autocorrelation pattern can be identified by the wide stretches of areas with the same colour, indicating that similar regions tend to aggregate geographically. As such, we can see a group of rich regions in the north and east of Spain which contrasts with the south and west of the Iberian Peninsula, including almost all the Portuguese regions. The map also shows some atypical cases of rich regions without spatial dependence with their neighbouring regions (La Coruna, Pontevedra, Salamanca and Grande Lisboa, among others).

Table 2
Moran's I statistic

	Portugal and Spain		Portugal		Spain	
Year	Moran I	Mg. Prob.	Moran I	Mg. Prob.	Moran I	Mg. Prob.
1995	0.7277	0.0000	0.3709	0.0002	0.6886	0.0000
1996	0.7319	0.0000	0.3554	0.0003	0.6789	0.0000
1997	0.7089	0.0000	0.3881	0.0001	0.6690	0.0000
1998	0.6914	0.0000	0.3786	0.0001	0.6495	0.0000
1999	0.6731	0.0000	0.3423	0.0004	0.6280	0.0000
2000	0.6705	0.0000	0.3251	0.0008	0.6239	0.0000
2001	0.6890	0.0000	0.3131	0.0011	0.6399	0.0000
2002	0.7029	0.0000	0.3198	0.0009	0.6396	0.0000
2003	0.7140	0.0000	0.3144	0.0011	0.6355	0.0000
2004	0.7290	0.0000	0.2993	0.0018	0.6292	0.0000
2005	0.7293	0.0000	0.2774	0.0035	0.6102	0.0000
2006	0.7483	0.0000	0.3322	0.0006	0.6129	0.0000
2007	0.7581	0.0000	0.3399	0.0005	0.6322	0.0000
2008	0.7469	0.0000	0.3025	0.0016	0.6319	0.0000

Source: Own calculations based on data from national statistics offices.

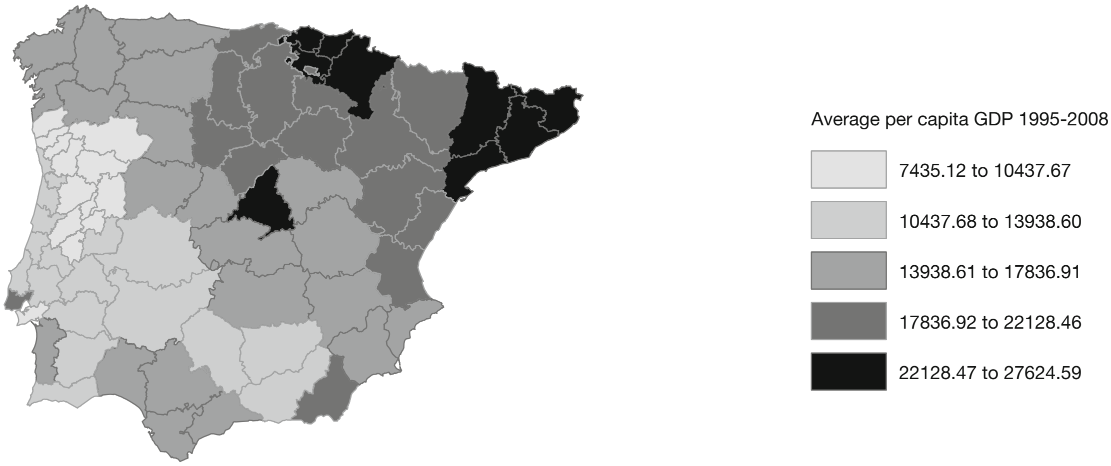
The distribution of the growth rate of per capita GDP between 1995 and 2008 (Figures 4 and 5) is more heterogeneous across the territory. The highest growth rates belong to Spanish regions, namely Badajoz, Huelva, Cadiz and Almeria in the south, and Vizcaya, Alava, Guipuzcoa, Pontevedra, Asturias, Cantabria and Zamora in the north. The lowest growth rates are observed in five Portuguese regions: Baixo-Vouga, Ave, Grande Porto, Lezíria do Tejo and Península de Setúbal. The Moran scatter plot shows a concentration of regions in the first and second quadrants (56 regions, equivalent to 75% of all regions), confirmed by the Moran's I indicator of 0.44 with a high level of significance.

Finally, we use a spatial econometric methodology to estimate a model of absolute beta-convergence for the Iberian NUTS 3 regions for the 1995-2008 period. First, we estimate the simple model of beta-convergence according to equation (1) with and without a national dummy. The next step is to detect the presence and type of spatial effects in order to evaluate whether the spatial lag model or the spatial error model is most appropriate to describe the data. We follow the robust LM tests described in Elhorst,[25] which test the type of spatial dependence based on the residuals of the non-spatial models.[26]

25 J. Elhorst: Spatial Panel Data Models, in: M.M. Fischer, A. Getis (eds.): Handbook of Applied Spatial Analysis, Berlin, Heidelberg, New York 2009, Springer, pp. 377-408.

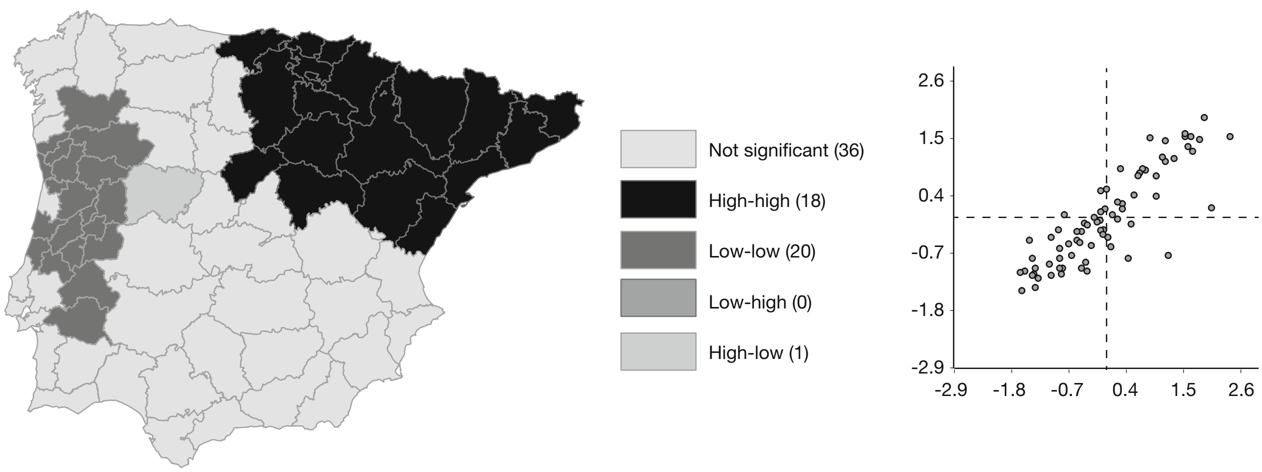
26 MATLAB routines available at www.regroningen.nl/elhorst.

Figure 2
Average per capita GDP 1995-2008, Spanish and Portuguese regions (NUTS 3)



Source: National statistics offices.

Figure 3
Average per capita GDP 1995-2008, Spanish and Portuguese regions (NUTS 3).
LISA cluster map (left-hand side) and Moran scatter plot (right-hand side) (Moran's I = 0.7277)



Source: Own calculations based on data from national statistics offices.

The results for all the regions of the Iberian Peninsula are presented in the first column of Table 3. They indicate that the specification of the spatial error model in which only disturbances exhibit spatial dependency, given by Equation (3), is adequate for the convergence process (λ represents the spatial autoregressive parameter in the error term). The results of the three spatial autocorrelation tests can be seen at the bottom of the table. The LM robust error test[27] indicates the presence of spatial correlation in the residuals of the regression model.

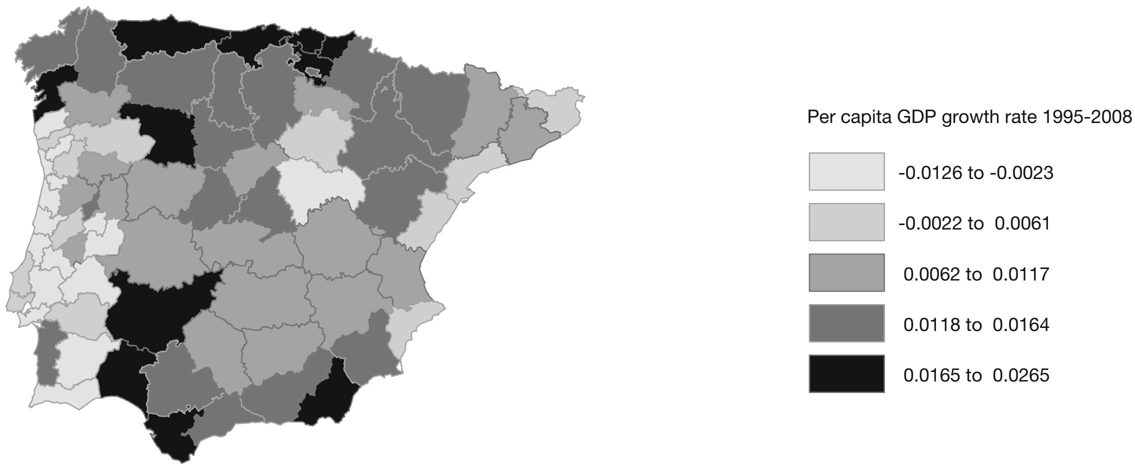
$$\frac{1}{T}\ln\frac{y_{i,T}}{y_{i,0}} = \alpha + \beta \ln y_{i,0} + u_i$$

$$\text{where } u_i = \lambda W u_i + \varepsilon_i \qquad (3)$$

With the spatial error dependence model (column 2), the slight beta-divergence process estimated by the OLS model ceases to be significant. This excludes the presence of a catching-up effect among the poorest regions, as would be predicted according to the sigma-divergence detected above. Therefore, the results, namely the pres-

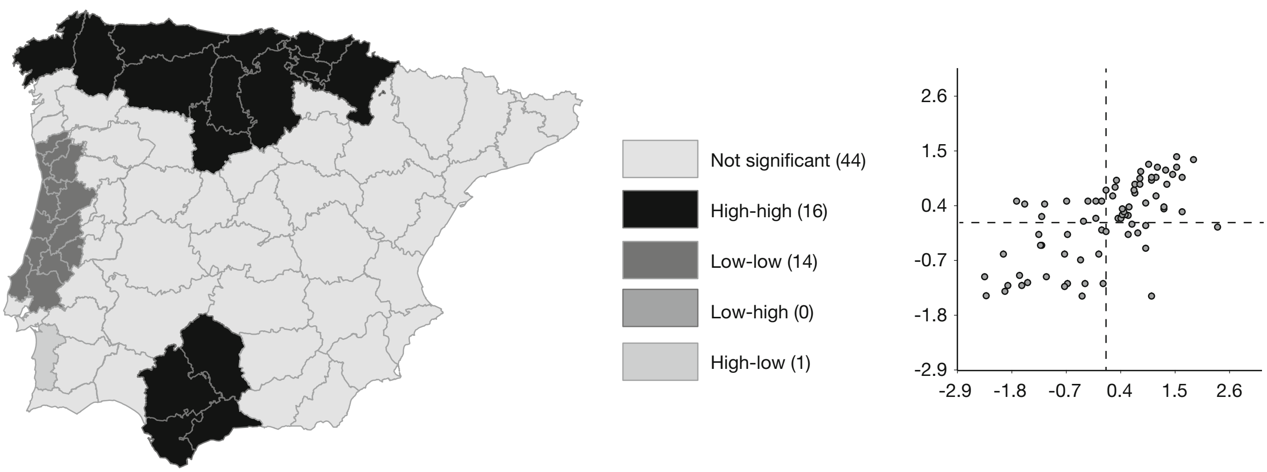
27 J. Elhorst, op. cit.

Figure 4
Per capita GDP growth rate 1995-2008, Spanish and Portuguese regions (NUTS 3)



Source: National statistics offices.

Figure 5
Per capita GDP growth rate 1995-2008, Spanish and Portuguese regions (NUTS 3).
LISA cluster map (left-hand side) and Moran scatter plot (right-hand side) (Moran's I= 0.4412)



Source: Own calculations based on data from national statistics offices.

ence of a strong spatial effect, confirm the existence of a polarisation of economic activity at the Iberian Peninsula scale.

Columns (3) and (4) of Table 3 present the results of estimating the same equation with the inclusion of a dummy variable for Spain. They indicate the spatial error model given in Equation (4) as the more appropriate one. As expected, the estimation shows a highly significant dummy coefficient and a slow beta-convergence process (with a velocity of convergence of 1% per year and a half-life of 69 years), compatible with individual sigma-convergence processes in each country, as well as a significant spatial dependence on the error term.[28]

$$\frac{1}{T}\ln\frac{y_{i,T}}{y_{i,0}} = \alpha + \beta \ln y_{i,0} + \delta.spain + u_i$$

where $u_i = \lambda W u_i + \varepsilon_i$ (4)

28 We also introduced a national dummy variable multiplied by the initial income level in order to detect differences in the convergence rate, but the estimation does not detect any statistical significance.

After confirming the spatial heterogeneity in the form of a national effect, we estimate separately the convergence process in the two countries. The results provide little evidence for a beta-convergence process in Spain (OLS in column 5 and Spatial Error Model in column 7) and are insignificant in the Spatial Error Model (with a p-value just above 10%). The strong spatial dependence in the error term confirms the effect of non-observable variables that may have contributed to the development of contiguous areas, improving (slightly) the income distribution. As for the Portuguese regions (column 6), the OLS estimation reveals a statistically significant beta-convergence process, although one that is rather slow and without spatial dependence. The velocity of convergence is 1.2% per year with a half-life of 58 years.

Table 3
Estimations results and spatial tests. Beta-convergence, 1995-2008
(p-values in parentheses)

Models	OLS (ES+PT) 1	SEM (ES+PT) 2	OLS (ES+PT) 3	SEM (ES+PT) 4	OLS (ES) 5	OLS (PT) 6	SEM (ES) 7
				Estimation			
Obs	75	75	75	75	47	28	47
R^2	0.1017	0.3875	0.5710	0.5978	0.0682	0.1698	0.2333
Constant	0.0025 (0.9283)	0.0678 (0.0786)	0.1558 (0.0000)	0.1621 (0.0000)	0.1556 (0.0000)	0.1727 (0.0003)	0.1636 (0.0005)
β	0.0091 (0.0053)	0.0019 (0.6587)	-0.0092 (0.0034)	-0.0099 (0.0035)	-0.0072 (0.0763)	-0.0111 (0.0293)	-0.0081 (0.1141)
δ	-	-	0.0176 (0.0000)	0.0182 (0.0000)	-	-	-
λ	-	0.6740 (0.0000)	-	0.3180 (0.0549)	-	-	0.4930 (0.0046)
				Autocorrelation tests			
Moran I	55.444 (0.0000)	-	24.788 (0.0132)	-	36.993 (0.0002)	0.3302 (0.7413)	-
LM lag (robust)	0.0196 (0.8890)	-	0.4294 (0.5120)	-	0.4459 (0.5040)	0.0112 (0.9160)	-
LM error (robust)	191.410 (0.0000)	-	43.358 (0.0370)	-	89.440 (0.0030)	0.0027 (0.9590)	-

Source: Own calculations based on data from national statistics offices.

Conclusion

Using a spatial econometric framework, this paper empirically analyses convergence among NUTS 3 regions of the Iberian Peninsula between 1995 and 2008. The reduction of disparities in the levels of development of the various regions and of the backwardness of the least favoured regions represents one of the main objectives of the EU. Since joining the EU, Portugal and Spain have recorded impressive economic growth, converging towards the EU average. However, there remain concerns about persistent regional asymmetries.

At the Iberian Peninsula scale, our results point to a sigma-divergence process between 1995 and 2008, while at the national level, both countries have followed a sigma-convergence process during the same period. This apparent contradiction reveals a worrying divergence between Spain and Portugal (from 2000 onwards) as well as a strong national effect that has apparently precluded some Portuguese border regions from benefiting from the impressive economic growth of some Spanish border regions like Huelva, Badajoz, Zamora or Pontevedra.

The results also point to some qualitative differences in the convergence pattern between Spanish and Portuguese regions. In the former, we found limited and insignificant beta-convergence with strong spatial dependence in the error term, while in the latter, the estimation reveals a slow but significant beta-convergence process, without spatial dependence. This subtle difference means that in the Spanish case, the spatial effects are crucial to the decrease of regional dispersion, while in the Portuguese case, in which spatial effects were not detected, a catching-up process of depressed regions seems to be at the core of the improvement of income distribution. As shown above, Spanish regions with high growth rates, e.g. Badajoz, Vizcaya, Pontevedra or Almeria, are always surrounded by regions with equally high growth. Conversely, the Portuguese regions with the highest growth rates (Alentejo Litoral and Serra da Estrela, two regions that have received significant public investments) did not seem to have any positive effects on the respective contiguous regions. These results raise multiple issues about the application of Structural Funds and the types of growth they generate, leading the way for further investigation.

In 1990 the European Commission integrated a special initiative for border regions into EU cohesion policy instruments known as INTERREG in order to promote cross-border co-operation (INTERREG-A). Since then, two other INTERREG-A generations were completed (1994-1999 and 2000-2006), and another one is currently included in the Territorial Co-operation objective (2007-2013). We did not formally test the presence of spatial effects across the border. However, our results confirm a strong national club effect and the incapacity of the Portuguese border regions to capture positive cross-border effects from prosperous Spanish regions. The inclusion of physical and human capital, population, and additional explaining factors is another reasonable line of investigation to further explore the behaviour of the NUTS 3 regions of the Iberian Peninsula with regard to growth and convergence.