

The Spatial Convergence of Knowledge in Portugal

Gertrudes Saúde Guerreiro *¹, António Bento Caleiro #²

**Department of Economics & CEFAGE-UE, University of Évora, Largo dos Colegiais, n.º.2, 7000-803 Évora, Portugal*

¹gdsg@uevora.pt

Department of Economics, University of Évora, Largo dos Colegiais, n.º.2, 7000-803 Évora, Portugal

²caleiro@uevora.pt

Abstract - Human resources are an essential element in territorial development. When these are characterized by a high level of training, they also enhance a number of effects in fundamental areas of binomial territorial-social cohesion. In this respect, the existence of higher education institutions throughout the territory allows the spread of human resources' qualification but, by itself, does not guarantee the retention of these resources in different regions. Thus, the objective of this paper is to undertake a spatial analysis of convergence of knowledge through studying the evolution of the percentage of population with higher education in the periods elapsed between the last three censuses in Portugal. Although that percentage has risen appreciably, the convergence is shown to be (very) insignificant.

Keywords: *Census, Convergence Analysis, Higher Education, Spatial Econometrics.*

1. Introduction

Human resources are an essential element in territorial development. When they are characterized by a high level of training, they enhance a series of effects which are essential in the relationship between territorial and social cohesion (Rego & Caleiro, 2010; Rego & Caleiro, 2012; Rego et al., 2012). In this regard, the existence of higher education institutions across the territory allows a delocalised qualification of human resources but, by itself, does not warrant the implantation of these resources in the various regions. Therefore, the main objective of this paper is to analyse the spatial convergence of knowledge through studying the evolution of the percentage of the population with higher education in the periods elapsed between the last three censuses in Portugal, i.e. between 1991-2001 and 2001-2011.

In the majority of empirical studies, regional (or spatial) economic convergence is studied from the viewpoint of the GDP growth *per capita* (see the work of

Barro and Sala-i-Martin). However, since human capital is a key factor in economic growth it seems important to know the spatial distribution of that kind of capital and whether regions have converged in terms of the stock of qualified human resources. In fact, a relevant spatial convergence of knowledge is expected to be reflected in spatial convergence in terms of economic growth, or even of unemployment rates.

Regarding conditional convergence of average *per capita* income in the regions of mainland Portugal,¹ Guerreiro (2014) concludes that the percentage of the workforce with higher education is a significant variable in distinguishing the 'steady state'² of regional economies. As mentioned in Tano (2014), concerning an empirical study in Sweden, the spatial distribution of human capital influences regional differences in terms of economic growth and prosperity. This study reveals a regional clustering of human capital in Sweden, with special relevance for major urban areas. In Portugal, when regional differences in terms of average remuneration are analysed, most above-average municipalities are located (with rare exceptions) in the metropolitan areas of Lisbon and Oporto, justified precisely by the concentration of highly qualified human capital (associated with highly-paid occupations) in these regions (Guerreiro, 2014).

The remainder of the paper is structured as follows: Section 2 presents and describes the data; Section 3 uses a spatial econometrics methodology to study the potential process of convergence; Section 4 concludes.

¹ This study aims to ascertain whether the Portuguese standard of living depends on place of residence. Convergence is studied in terms of income (*per capita* average wages) in the municipalities of continental Portugal.

² Steady state, in that growth is constant and may even be equal to zero. This "steady state", in each economy tends to converge in the medium and long term, according to Lee (1995), depending on the "social skills", which may support or inhibit the use of the "relative delay potential" in the growth process.

2. Description of data

The data correspond to the percentage of the resident population in the mainland that, at the time of the 1991, 2001 and 2011 censuses, had completed higher education.³ The geographical unit considered corresponds to NUTs 3.⁴

Figures 1, 2 and 3 show geographical representation of the data.⁵

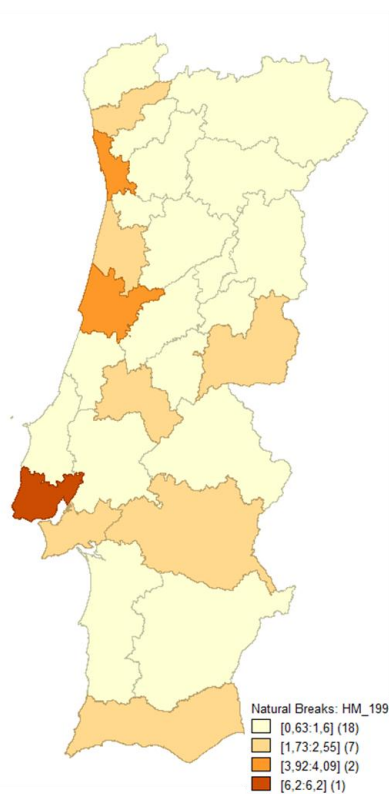


Figure 1. Percentage of the population with higher education in 1991

In general terms, the Portuguese population, especially in the period 1991-2001, registered a significant increase in terms of higher education, and in more specific terms, i.e. in certain regions and notably in the period 2001-2011.⁶ This increase, could represent regional harmonization, as the three major University clusters around Lisbon, Porto and Coimbra stand out clearly in the figures. This process will be studied in the following section.

³ The source of the data – which can be found in an attachment – is the National Institute of Statistics. Given the level of geographical disaggregation of data, as far as we know, there are no data for other (intermediate) years. So, unfortunately, we could not analyze the data for the years 1994, 1997, 2004 and 2007, as the suggested by the reviewer.

⁴ At this level of geographical disaggregation, the distinction of data by gender is not available for the 1991 Census, which meant it was only possible to analyse the (possible) convergence process of the population with higher education, by gender, in the period 2001-2011.

⁵ The figures were produced using the GeoDa™ 1.4.6, available at <http://geodacenter.asu.edu/>.

⁶ This increase in values implied that, for the sake of comparability in the two periods under analysis, standardisation was performed (Chen, 2013).

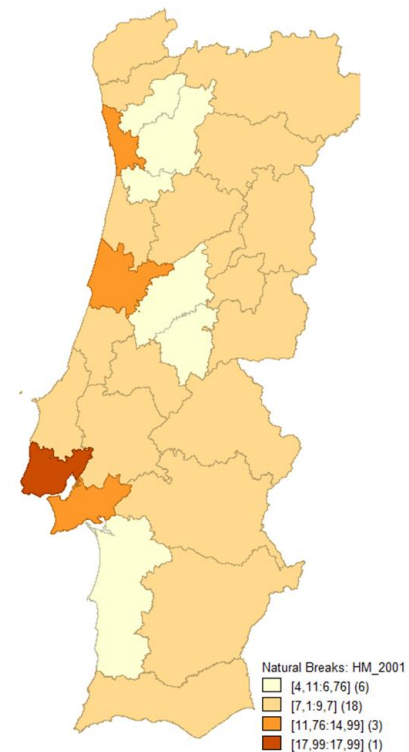


Figure 2. Percentage of the population with higher education in 2001

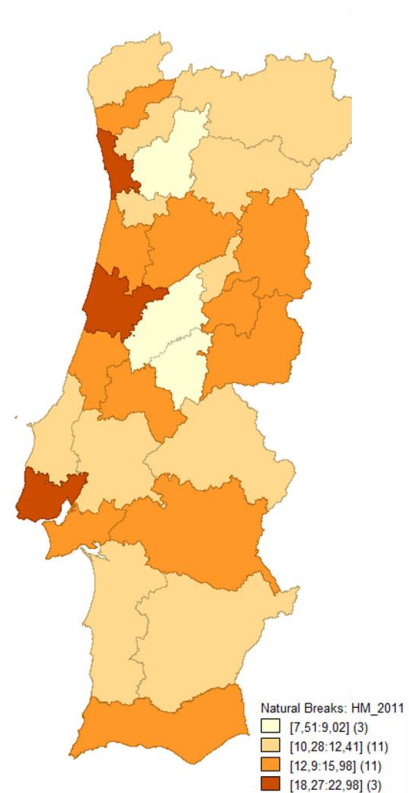


Figure 3. Percentage of the population with higher education in 2011

3. The process of spatial convergence

3.1 The methodology

The spatial convergence process of the population rates with higher education – understood as an approximation of the values for these proportions – will be studied using standard spatial econometrics methodology, i.e. by comparing the values recorded for each geographical unit, in this case NUTs 3, with the values recorded for neighbouring geographical units (Guerreiro & Caleiro, 2012). Traditionally, neighbourhood relationships are defined through a spatial weights matrix in which, for example, a weight is 0 if geographical units do not share a common border (or at least one point) and 1 otherwise. More recently (and more appropriately) this dichotomy has been replaced by the consideration that spatial weights are, for example, an inverse function of the geographical distance between geographical units, or more specifically, between their centroids (Chen, 2013).

The largest towns being considered the centroids of NUTs 3 (according to the number of inhabitants), the matrix of distances between the centroids of the NUTs 3 of mainland Portugal can be observed in Figure 4.

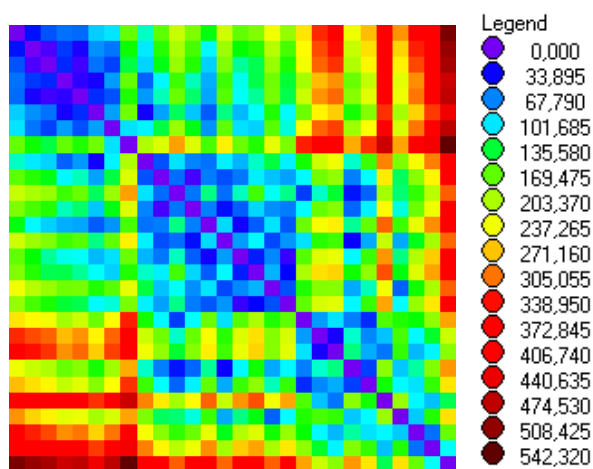


Figure 4. Matrix of the distance in kilometres between NUTs

In order to check how observations have evolved, it is important to distinguish a possible local convergence process between one NUT and its neighbouring NUTs and another possible regional one, between the NUT and its neighbouring NUTs and the national average. Four quadrants can then be distinguished: (NE: NUT and neighbours above the national average; NW: NUT below national average and neighbours above national average; SW: NUT and neighbours below national average; SE: NUT above national average and neighbours below national average).

In any case, it is important to check the location in the 4 quadrants, and whether that location has changed to another quadrant, possibly towards the bisecting line (indicating a local approach) and/or towards the origin (indicating a regional convergence).⁷

3.2 Results and findings

Application of this methodology produced the results shown in Figures 5 and 6.⁸

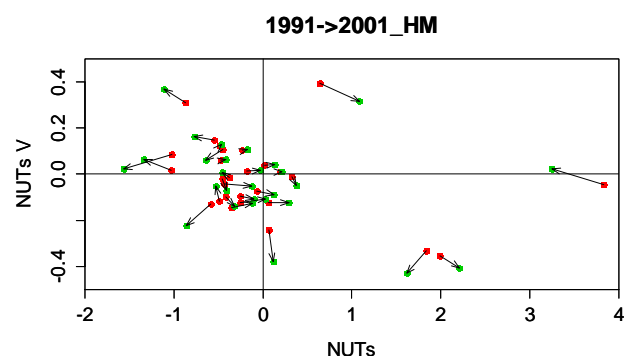


Figure 5. Spatial convergence process between 1991 and 2001

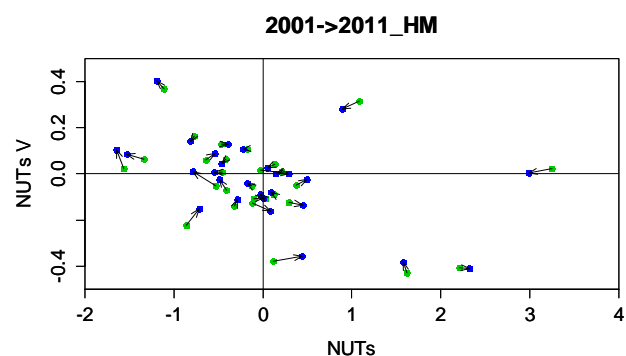


Figure 6. Spatial convergence process between 2001 and 2011

As Figures 5 and 6 clearly identify, there was some 'movement' in the period 1991-2001, but of very little significance in terms of changes in positions in the quadrants, this being even more evident in the period 2001-2011.

The movements between the quadrants of the spatial autocorrelation scatter plot in the periods 1991-2001 and 2001-2011 can be found, respectively, in Tables 1 and 2, and in Figures 7 and 8.

⁷ It should be noted that as the data is standardized, the national average coincides with the value 0.

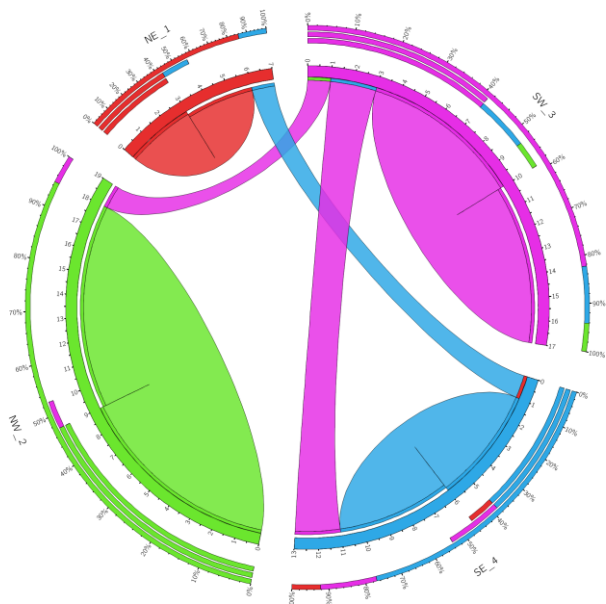
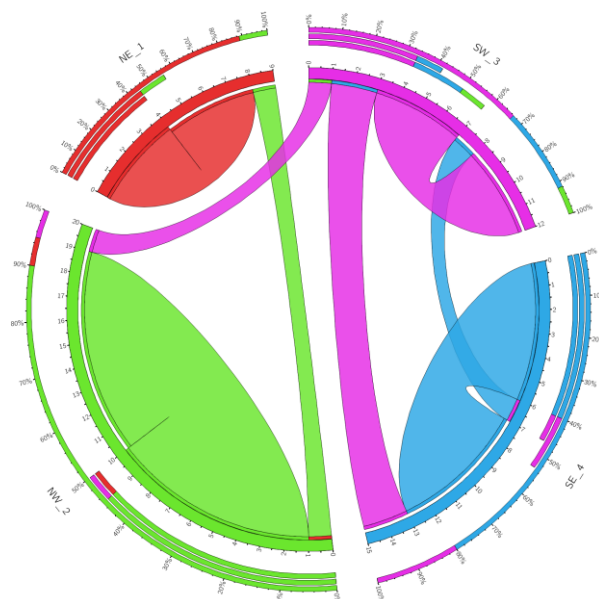
⁸ The figures were produced using the arrows command of the R graphics package.

Table 1. Location movements by quadrants (1991-2001)

| From\To | NE_1 | NW_2 | SW_3 | SE_4 |
|---------|------|------|------|------|
| NE_1 | 3 | 0 | 0 | 0 |
| NW_2 | 0 | 9 | 0 | 0 |
| SW_2 | 0 | 1 | 7 | 2 |
| SE_4 | 1 | 0 | 0 | 5 |

Table 2. Location movements by quadrants (1991-2001)

| From\To | NE_1 | NW_2 | SW_3 | SE_4 |
|---------|------|------|------|------|
| NE_1 | 4 | 0 | 0 | 0 |
| NW_2 | 1 | 9 | 0 | 0 |
| SW_2 | 0 | 1 | 4 | 2 |
| SE_4 | 0 | 0 | 1 | 6 |

**Figure 7.** Movement between quadrants in the period 1991-2001⁹**Figure 8.** Movement between quadrants in the period 2001-2011

The possibility of discriminating by gender shows that, despite the male population indicating characteristics of greater mobility, the convergence process (in the period 2001-2011) did not alter significantly the relative position of the various NUTs concerning the proportion of their population with higher education.

4. Conclusion

According to many economic indicators, Portugal is known to be a country with regional inequalities, and this is also apparently true regarding the location of its most skilled human resources.

The main objective of this paper is therefore to analyze the spatial convergence of knowledge through studying the evolution of the percentage of population with higher education in the periods elapsed between the last three censuses in Portugal, i.e. between 1991-2001 and 2001-2011. Indeed, the Portuguese population registered, in general terms especially in the 1991-2001 period, a significant increase in terms of higher education, and more specifically, i.e., in some regions, particularly in the period 2001-2011.

This paper showed that, despite qualifications, measured by the percentage of the resident population with higher education, having risen considerably (from 1991 to 2011), in Portugal, the process of regional convergence (of knowledge) was of (very) little significance.

As for the implications of that result, it casts some doubt on the results of alleged territorial cohesion

⁹ Figures 7 and 8 were produced with recourse to online CIRCOS. <http://mkweb.bcgsc.ca/tableviewer/visualize/>.

policies. It is known that the lower the starting level of inequality, the easier it is to reach the convergence process (Caleiro, 2009). From this point of view, in terms of policy lessons, it becomes urgent to resort to measures that indeed contribute to reversing the (spatial) divergence process which obviously characterizes Portugal.

Regarding potential avenues for new analysis, it seems important to consider other variables that are also attributable to the potential effects of possessing a certain level of knowledge, for example, productivity levels or unemployment rates (differentiated by level of education). From this point of view, a convergence analysis of (un)employment rates is to be considered as complementary to this study (see, for instance, the study of Guerreiro et al. in this special number).

Acknowledgments

The comments and suggestions of anonymous referees are gratefully acknowledged. The first author is also pleased to acknowledge financial support from Fundação para a Ciência e a Tecnologia and FEDER/COMPETE (grant UID/ECO/04007/2013).

References

- [1] Caleiro, António (2009), “Um estudo de simulação sobre o processo de empobrecimento/enriquecimento humano e físico das regiões”, Livro de Actas do XV Congresso da Associação Portuguesa para o Desenvolvimento Regional, APDR, Setembro, Angra do Heroísmo, pp. 977-994, (ISBN: 978-989-96353-0-2).
- [2] Chen, Yanguang (2013), “New Approaches for Calculating Moran’s Index of Spatial Autocorrelation”, PLoS ONE, 8: 7.
- [3] Guerreiro, Gertrudes (2014), “Regional Income Convergence in Portugal (1991-2002)”, Research on Economic Inequality, 22, Emerald Group Publishing Limited, (no prelo).
- [4] Guerreiro, Gertrudes; Caleiro, António (2005), “Quão Distantes Estão as Regiões Portuguesas? Uma aplicação de escalonamento multidimensional”, Revista Portuguesa de Estudos Regionais, 8: 1.º Quadrimestre, 47-59.
- [5] Guerreiro, Gertrudes Saúde; Caleiro, António (2012), “Regional Income Differences in Borderlands: A Convergence Analysis”, International Journal of Latest Trends in Finance and Economic Sciences, 2: 4, 305-307.
- [6] Lopes, J. (1995), “Crescimento Económico e Convergência: Questões Teóricas, Métodos Empíricos e uma Abordagem ao Caso Português”, ISEG, Universidade Técnica de Lisboa.
- [7] Rego, Conceição; Caleiro, António (2010), “On the Spatial Diffusion of Knowledge by Universities Located in Small and Medium Sized Towns”, iBusiness, II: 2, pp. 99-105.
- [8] Rego, Conceição; Caleiro, António (2012), “Acerca dos impactes da Universidade de Évora no seu meio envolvente. Síntese de alguns resultados obtidos”, in Pereira, S.M.; Vaz, F.L. (coords.), Universidade de Évora (1559-2009). 450 anos de modernidade educativa, Lisboa, Chiado Editora, pp. 751-762.
- [9] Rego, Conceição; Baltazar, Maria da Saudade; Caleiro, António (2012), “Higher Education and Social Cohesion”, Higher Education of Social Science, 2: 2, 17-24.
- [10] Tano, Sofia (2014), “Regional clustering of human capital: school grades and migration of university graduates”, The Annals of Regional Science, 52: 2, 561-581.

Annexes

Table 3. Percentage of the resident population with higher education

| | HM_1991 | HM_2001 | H_2001 | M_2001 | HM_2011 | H_2011 | M_2011 |
|-----------------------|---------|---------|--------|--------|---------|--------|--------|
| Minho-Lima | 1.29 | 7.45 | 6.57 | 8.22 | 11.36 | 9.81 | 12.72 |
| Cávado | 1.89 | 8.95 | 7.81 | 10.02 | 14.47 | 12.42 | 16.37 |
| Ave | 1.14 | 6.14 | 5.23 | 7.01 | 10.60 | 8.95 | 12.14 |
| Grande Porto | 3.92 | 13.28 | 12.41 | 14.08 | 18.27 | 16.74 | 19.64 |
| Tâmega | 0.64 | 4.11 | 3.26 | 4.93 | 7.51 | 5.92 | 9.02 |
| Entre Douro e Vouga | 1.30 | 6.76 | 5.70 | 7.78 | 11.20 | 9.36 | 12.92 |
| Douro | 1.33 | 7.71 | 6.61 | 8.74 | 12.03 | 10.20 | 13.71 |
| Alto Trás-os-Montes | 1.31 | 8.25 | 6.66 | 9.76 | 12.41 | 9.96 | 14.67 |
| Baixo Vouga | 2.18 | 9.70 | 8.59 | 10.73 | 14.64 | 12.66 | 16.46 |
| Baixo Mondego | 4.09 | 14.99 | 13.83 | 16.03 | 20.74 | 18.72 | 22.55 |
| Pinhal Litoral | 1.60 | 8.55 | 7.15 | 9.87 | 13.98 | 11.69 | 16.12 |
| Pinhal Interior Norte | 0.81 | 5.43 | 4.48 | 6.32 | 9.02 | 7.40 | 10.49 |
| Dão-Lafões | 1.52 | 8.32 | 7.13 | 9.42 | 13.01 | 11.13 | 14.70 |
| Pinhal Interior Sul | 0.63 | 4.76 | 4.23 | 5.24 | 7.90 | 6.58 | 9.10 |
| Serra da Estrela | 1.25 | 7.10 | 5.96 | 8.15 | 10.36 | 8.71 | 11.83 |
| Beira Interior Norte | 1.52 | 8.71 | 7.26 | 10.03 | 12.90 | 10.53 | 15.04 |
| Beira Interior Sul | 1.88 | 9.46 | 8.46 | 10.39 | 14.48 | 12.63 | 16.15 |
| Cova da Beira | 1.41 | 8.29 | 7.32 | 9.19 | 13.29 | 11.47 | 14.96 |
| Oeste | 1.26 | 7.28 | 6.14 | 8.38 | 11.68 | 9.70 | 13.53 |
| Grande Lisboa | 6.20 | 17.99 | 17.74 | 18.22 | 22.98 | 21.80 | 24.03 |
| Península de Setúbal | 2.55 | 11.76 | 10.69 | 12.77 | 15.98 | 14.26 | 17.55 |
| Médio Tejo | 1.73 | 8.98 | 7.84 | 10.04 | 13.31 | 11.33 | 15.10 |
| Lezíria do Tejo | 1.55 | 8.12 | 7.02 | 9.17 | 12.24 | 10.26 | 14.08 |
| Alentejo Litoral | 1.18 | 6.40 | 5.21 | 7.59 | 10.28 | 8.34 | 12.19 |
| Alto Alentejo | 1.38 | 7.30 | 6.43 | 8.12 | 11.18 | 9.53 | 12.71 |
| Alentejo Central | 1.83 | 9.00 | 7.77 | 10.15 | 13.17 | 11.09 | 15.09 |
| Baixo Alentejo | 1.27 | 7.42 | 5.83 | 8.98 | 11.45 | 9.21 | 13.59 |
| Algarve | 2.04 | 9.24 | 8.12 | 10.33 | 13.50 | 11.35 | 15.54 |



Figure 9. Map of Portuguese NUTs 3